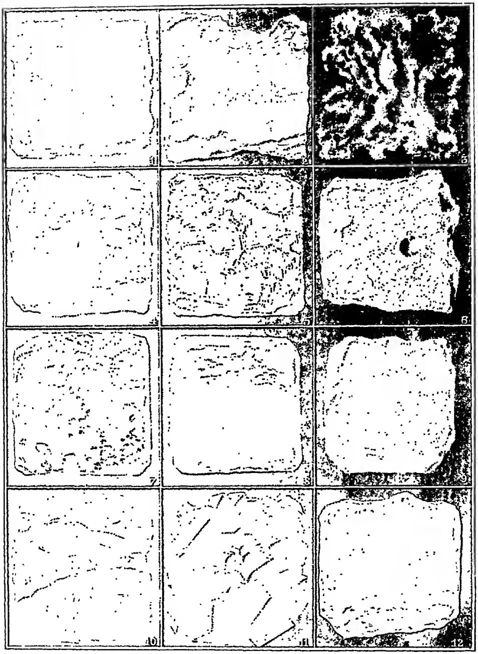

CASSELL & COMPANY LIMITED LITH LONDON

ORES OF METALS.

1, Section of rich Gold-bearing Quartz; 2, Green Malachite $CuCO_3 + Cu(HO)_2$ with Azurite $2CuCO_3 + Cu(HO)_2$; 3, Native Metallic Copper; 4, Orpiment As_2S_3; 5, Realgar As_2S_2; 6, Cuprite Cu_2O; 7, Red Oxide of Zinc ZnO; 8, Noumeite, a green silicate of Nickel and Magnesium; 9, Cinnabar HgS; 10, Hæmatite Fe_2O_3, showing blood-red "streak"; 11, Galena PbS, with violet Fluorspar; 12, Manganese Spar $MnCO_3$.

THE

NEW POPULAR EDUCATOR

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OF

ELEMENTARY AND ADVANCED EDUCATION

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CASSELL'S

NEW POPULAR EDUCATOR.

CHEMISTRY.—X.

[Continued from Vol. IV., p. 324.]

THE METALS: GENERAL PROPERTIES AND METHODS OF EXTRACTION—METALS OF THE ALKALIES—SODIUM—SALT—WASHING SODA—WATER OF CRYSTALLISATION—BICARBONATE OF SODA—POTASSIUM—NITRE—GUNPOWDER—AMMONIUM—METALS OF THE ALKALINE EARTHS—CALCIUM—LIME—MORTAR—CEMENT—CHALK—STRONTIUM—BARIUM.

If we take a typical metal, as silver, iron, or copper, we find that when polished it acquires a brilliant reflecting surface, known as the metallic lustre. It is opaque in the thinnest sheets; it can be hammered out into thin plates (malleable), and can be pulled through slightly conical holes in a steel plate into wire (ductile). It conducts heat and electricity well, and its oxides form bases. On closer examination, we find that all these properties merge almost insensibly into those of the non-metals. Thus, metals in a fine state of division lose their lustre. Gold, silver, copper, and other metals can be obtained in dull powders, which, however, usually regain their lustre when rubbed with a smooth hard surface (burnishing). On the other hand, iodine, tellurium, and graphite or black lead have a marked lustre. Gold leaf can be obtained so thin ($\frac{1}{250,000}$ths of an inch in thickness) that it allows a greenish light to pass through. Some metals—as bismuth and antimony—are very brittle, and can neither be hammered out nor drawn into wire; while some of the oxides of chromium and manganese form well marked acids. So that although a typical metal can easily be distinguished from a typical non-metal, in some cases it is very difficult to draw the line; thus, in modern text-books some consider arsenic with the non-metals, on account of its strong resemblance to phosphorus, whilst others class arsenic among the metals.

Many metals form mixtures with other metals called *alloys*. Thus copper and zinc melted together form brass; copper and tin, bronze, etc. In a few cases, these alloys seem to be chemical compounds, as aluminium bronze (Cu_9Al): they may in general be regarded as solid solutions. When one of the metals is mercury, the mixture is called an *amalgam*.

A few metals are found native—gold, platinum, bismuth, copper, silver, mercury; but most occur as oxides, sulphides, carbonates, silicates, and chlorides. The metallic ores are generally much heavier than the substances with which they are found, and so can be separated from them by washing on inclined plates, etc.: the heavier metallic minerals settling rapidly, while the lighter impurities—clay, sand, etc.—are washed away. The ore is next usually roasted, that is, heated with free access of air; this converts the ore into an oxide, which is finally heated with carbon, either as charcoal, coal, or coke: *e.g.*, lead is found as sulphide, on roasting this is converted into oxide, $PbS + 3O = PbO + SO_2$; on heating with carbon, $PbO + C = Pb + CO$.

The metals magnesium and aluminium are obtained by heating the dry chlorides with metallic sodium—

$$Al_2Cl_6 + 6Na = 2Al + 6NaCl.$$

METALS OF THE ALKALIES.

Lithium (Li), atomic weight, 7; Sodium (Na), 23; Potassium (K), 39; Rubidium (Rb), 85; Cæsium (Cs), 133.

All these metals are monads, soft, and easily fusible. They decompose water at ordinary temperatures. The hydrates KHO, NaHO, etc., are very soluble in water; the solution is caustic, dissolving the skin, and when boiled with fats, converts them into soaps. The carbonates are also soluble in water, and give, like the hydrates, strongly alkaline solutions. Their salts are mostly soluble, and colour the Bunsen flame. Their spectra exhibit but a small number of lines. (*See* Coloured Plate of Spectra, K and Na, Frontis., Vol. IV.).

Sodium. Na (*natrium*), atomic weight, 23, is a bright silvery metal, which tarnishes instantly in the air, being converted on the surface into an oxide, and so it has to be kept under petroleum naphtha, a liquid which contains no oxygen. When heated, sodium burns with a bright yellow flame; thrown upon water, it decomposes it, forming sodium hydrate and liberating hydrogen, which takes fire if the water be warm.

Sodium is prepared by heating the carbonate with charcoal powder in iron retorts—

$$Na_2CO_3 + 2C = 2Na + 3CO.$$

The sodium comes over in vapour, which is condensed in suitable receivers.

A great improvement has been effected by the introduction of Castner's process, in which sodium hydrate is heated with a carbide of iron—

$$6NaHO + \underbrace{FeC_2}_{\text{Iron carbide.}} = 2Na_2CO_3 + 6H + Fe + 2Na.$$

The carbide of iron is prepared by mixing up finely divided iron with pitch. This mixture when cold is heated and converted into a coke, which is ground up very finely and mixed with the sodium hydrate. Sodium is largely used in the manufacture of aluminium, and as an amalgam with mercury for extracting gold from its ores. Sodium was first prepared by Davy in 1807, who passed a current of electricity through a mass of sodium hydrate slightly moistened with water.

Sodium Oxide (Na_2O) can be obtained by heating sodium in oxygen. It dissolves in water, evolving much heat, and forming sodium hydrate.

Sodium Hydrate (caustic soda), NaHO.—This substance is prepared on a large scale for soap-making by boiling a solution of sodium carbonate (Na_2CO_3) with slaked lime—

$$Na_2CO_3 + Ca(HO)_2 = 2NaHO + \underbrace{CaCO_3}_{\text{Calcium carbonate.}}$$

The calcium carbonate settles, and the clear liquid is evaporated until the residue fuses, when it is poured into moulds, and forms the ordinary stick caustic soda. It is a powerful alkali, very soluble in water, neutralises acids, dissolves organic matter. When boiled with fats, it forms ordinary soap (sodium stearate) and glycerine.

Sodium Chloride (salt), NaCl.—This well-known substance is found native in mines in Cheshire, Poland, etc., and is often prepared by evaporating sea-water, until the salt crystallises out. When found in the crystalline form in nature, it is called "rock-salt."

Sodium Carbonate (Na_2CO_3), ordinary washing-soda ($Na_2CO_3 + 10H_2O$).—This substance is of vast importance, being used in the manufacture of glass and soap. It is prepared by two processes:—

The Leblanc or Black Ash Process.—Ordinary salt is mixed with sulphuric acid in a cast-iron pan, and the mixture finally heated in two furnaces placed at the sides of the pan.

$$2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl—$$

the escaping gas is passed through a tower of wet coke, which dissolves out practically the whole of the hydrogen chloride. The mass of sodium sulphate—technically termed "salt-cake"—is mixed with crushed chalk or limestone and small coal, and the whole heated strongly. Two reactions go on simultaneously—

$$Na_2SO_4 + 4C = \underbrace{Na_2S}_{\text{Sodium sulphide.}} + 4CO$$

$$Na_2S + CaCO_3 = Na_2CO_3 + \underbrace{CaS}_{\text{Calcium sulphide.}}$$

The sulphate is first deprived of its oxygen by the coal, forming sodium sulphide, which is then converted by the chalk into carbonate. The carbonate of soda is extracted by hot water, and the clear solution allowed to crystallise. The residual calcium sulphide, with the excess of lime, forms the much dreaded "alkali waste."

The second process is the *Ammonia Soda Process*. A stream of carbon dioxide is passed under pressure through a solution of salt containing ammonia.—

$$CO_2 + NH_3 + NaCl + H_2O = \underbrace{HNaCO_3}_{\text{Sodium bicarbonate.}} + NH_4Cl$$

The solution of sodium bicarbonate on evaporation evolves carbon dioxide, which is used over again, while the ammonium chloride, when treated with lime, liberates ammonia (*see* Vol. IV., p. 129), which is again utilised. So that the only waste product is calcium chloride, which is quite inoffensive.

Ordinary washing-soda crystallises with ten molecules of water of crystallisation ($Na_2CO_3 + 10H_2O$), which it evolves in a dry atmosphere, and then crumbles to a white powder. Some substances have the power of combining with water and keeping it in the solid form far above its ordinary melting-point. The form of the crystal depends on the presence of this water, which is, however, readily driven off by a gentle heat. Water, when thus kept in the state of ice far above its ordinary melting point, is termed "water of crystallisation." When strongly heated, all the water is given off, and anhydrous sodium carbonate (Na_2CO_3) is left as a white powder.

Sodium Bicarbonate or *Acid Sodium Carbonate*

($HNaCO_3$) is prepared by passing carbon dioxide over moist sodium carbonate—

$$Na_2CO_3 + H_2O + CO_2 = 2HNaCO_3.$$

The ordinary carbonate of soda sold by the chemist and druggist is usually bicarbonate.

Sodium Nitrate (Chili saltpetre), $NaNO_3$, occurs in immense deposits in certain rainless districts of Chili and Peru, whence it is exported in enormous quantities as the well known "nitrates." It is used in the preparation of nitric acid, and as a manure for crops.

Sodium salts all give an intense yellow colour to a Bunsen flame. This yellow flame, when viewed through an ordinary spectroscope, exhibits one bright yellow line. (*See* Coloured Plate.)

Potassium, K (*kalium*), atomic weight, 39.—This metal was prepared by Davy in 1807, using the same method as that employed by him to obtain sodium. It can also be obtained by heating potassium carbonate with charcoal, but the process is complicated by the simultaneous formation of an explosive substance which seems to be a compound of the metal with carbon monoxide, $K_2(CO)_2$. The mixture of carbonate and carbon is usually obtained by heating cream of tartar, $HKH_4C_4O_6$.

Potassium is also prepared by heating potassium hydrate with iron, and by Castner's process—the reaction being exactly the same as those already described under Sodium.

Potassium is a silvery white metal lighter than water, specific gravity = 0·86, its vapour is green; it decomposes water at ordinary temperatures, liberating hydrogen, which takes fire and burns with a pale violet flame.

Potassium Oxide (K_2O), and *Potassium Hydrate*, or caustic potash (KHO), closely resemble the corresponding sodium compounds, and are prepared in similar ways. Caustic potash when boiled with fats gives "soft soap."

Potassium Chloride (KCl), closely resembles ordinary salt; it is found in large quantities often combined with magnesium chloride in the potash mines in Stassfurt, which furnish a considerable proportion of the world's supply of potash salts.

Potassium Bromide (KBr), and *Potassium Iodide*, (KI), occur in colourless square crystals; they can be prepared by acting on a hot, strong solution of caustic potash with bromine or iodine—

$$6I + 6KHO = \underbrace{KIO_3}_{\text{Potassium iodate.}} + 5KI + 3H_2O.$$

The solution containing the mixed iodate and iodide is evaporated to dryness and gently ignited, when the iodate gives off its oxygen and six molecules of potassium iodide are left.

Potassium Chlorate, $KClO_3$, has already been referred to under Chloric Acid; it is manufactured by passing chlorine through a paste of slaked lime and water—

$$12Cl + 6Ca(HO)_2 = \underbrace{Ca(ClO_3)_2}_{\text{Calcium chlorate.}} + 6CaCl_2 + 6H_2O.$$

The clear solution is evaporated, and potassium sulphate is added, when potassium chlorate and calcium sulphate are formed—

$$Ca(ClO_3)_2 + K_2SO_4 = CaSO_4 + 2KClO_3.$$

The solution of potassium chlorate is decanted from the precipitate of calcium sulphate and evaporated until the salt crystallises out.

Potassium Carbonate, K_2CO_3.—This constitutes the original "potashes"; the ashes left after burning wood consisting largely of this substance, and before the Leblanc process of making sodium carbonate was discovered, it formed the sole alkali for cleansing purposes. In America much wood is burnt, and potassium carbonate is still made by extracting wood ashes with water and evaporating the solution; when these crude potashes are redissolved and recrystallised, the product is termed "pearlash." Large quantities of potassium carbonate are obtained by charring the pulp of the sugar beet which is left after the sugar has been extracted; another curious source is sheep wool—when the brown liquor in which the fleeces are washed is evaporated to dryness and the residue ignited, the potassium carbonate can be extracted with water and crystallised.

Potassium Bicarbonate.—Acid potassium carbonate, $HKCO_3$, is prepared by passing carbon dioxide through a strong solution of potassium carbonate, when the bicarbonate, which is much less soluble, separates out.

Potassium Nitrate (saltpetre, nitre), KNO_3.—This salt is of great importance, it is an essential ingredient in one of the necessities of modern civilisation—gunpowder—and it plays a very important part in the nourishment of plant life. All fertile soils contain nitrate of potassium or calcium. Nitre has been long known; in warm climates in which rainless periods occur, this salt is found as a sort of white crystalline growth or efflorescence, especially in the neighbourhood of drains, on the surface of the soil, rocks, etc., hence its name saltpetre (*sal petræ*, the salt of the rock). In India a caste of men gain their livelihood by scraping off the top layer of such soil and extracting the nitre from it with water. The explanation of this natural formation of nitre is extremely interesting. The nitrogen of the nitrogenous foods which we eat, meat, etc. (*see* Vol. I., p. 267), passes

out of the body principally as urea, $CO(NH_2)_2$. This substance rapidly decomposes into ammonium carbonate, which in its turn undergoes a slow process of oxidation in the upper layers of the soil, under favourable conditions of temperature and moisture, forming nitrates; these nitrates dissolve in the rain water, are absorbed by the vegetation, and elaborated into various complicated nitrogenous food stuffs, which are again consumed by animals, pass out as urea, etc., and so the nitrogen in this form passes through a never-ending cycle of changes. This natural process of nitrification is imitated artificially in the so-called nitre beds or plantations.

In gunpowder nitre furnishes the oxygen to burn up the charcoal powder—

$$2KNO_3 + S + 3C = 3CO_2 + N_2 + \underbrace{K_2S}_{\text{Potassium sulphide.}};$$

the cause of the explosion is the sudden liberation of a large quantity of heated gas. The volume of this gas at 0° Cent. is about 280 times that of the powder, the pressure developed may exceed 30 tons on the square inch, the temperature is very high, 2,200° Cent. Gunpowder varies slightly in its composition, it contains roughly about 75 parts of nitre to 14 of charcoal and 12 of sulphur. These ingredients are carefully ground up wet and the paste squeezed into a cake, which is broken up and sifted through parchment sieves; the grains are then glazed by shaking up with a little black lead. Potassium nitrate usually occurs in colourless crystals, which are very soluble in water.

All potassium salts give a pale violet colour to the Bunsen flame if pure, which becomes crimson when seen through deep blue glass; if a trace of sodium salt is present, the delicate violet flame coloration is completely overpowered, and to the eye the flame appears yellow; through the blue glass the crimson colour can, however, still be detected. With the spectroscope the violet flame gives two bands, one in the red and one in the violet. (*See* Coloured Plate.) Solutions of potassium salts give a white precipitate when stirred with tartaric acid solution.

The metals lithium, rubidium, and cæsium and their salts are so rare than any detailed description is unnecessary.

Ammonium, NH_4.—This positive radical replaces sodium and potassium in so many salts, and forms compounds which are so similar, that a few words as to its nature may be conveniently inserted here. Ammonium has never been isolated, but its existence is inferred from its presence in so many salts, *e.g.*, HN_4Cl and $(NH_4)_2SO_4$. NH_4 is sometimes symbolised Am, ammonium chloride AmCl, etc.

Some of the ammonium salts have already been described under Ammonia.

Ammonium Carbonate (sal volatile), is usually prepared by heating a mixture of chalk and ammonium chloride.

All ammonium salts when warmed with caustic potash, KHO, evolve ammonia gas; ordinary smelling-salts usually consist of a mixture of ammonium chloride and sodium carbonate, which when moistened gives off ammonium carbonate.

METALS OF THE ALKALINE EARTHS.

Calcium, Strontium, and Barium. These metals are all divalent; their hydrates are soluble in water, giving alkaline solutions; their carbonates, sulphates, and phosphates are almost insoluble in water. They can be prepared by passing a current of electricity through the fused chlorides. All the volatile salts, chlorides, nitrates, etc., colour the Bunsen flame; the non-volatile salts, carbonates, phosphates, sulphates, etc., give but slight flame colorations.

Calcium, Ca, atomic weight, 40, is a yellowish metal somewhat harder than lead; it is at present of no practical importance.

Calcium Oxide (quick or unslaked lime), CaO.—This well-known substance is prepared by heating chalk or limestone in kilns; the calcium carbonate is decomposed, carbon dioxide being evolved—

$$CaCO_3 = CaO + CO_2.$$

Lime is a whitish infusible solid; when heated in the oxyhydrogen jet it remains unmelted, but emits a most dazzling light (limelight or Drummond's light). Quick-lime absorbs, and combines most energetically with, water, giving out great heat, the quick-lime crumbling to a white powder termed "slaked lime," $Ca(HO)_2$. Quick-lime is therefore used in the laboratory for drying ammonia and other gases.

Calcium Hydrate (slaked lime), $Ca(HO)_2$, is largely used for making ordinary mortar, which should consist of a mixture of one part of lime to three or four parts of sand. After the mortar is mixed, the lime absorbs carbonic acid from the air, and the calcium carbonate thus formed acts as a cementing material, binding the whole firmly together—

$$Ca(HO)_2 + CO_2 = CaCO_3 + H_2O.$$

Calcium hydrate is slightly soluble in water, forming lime-water, which is faintly alkaline, and turns milky in the presence of carbonic acid.

Calcium Chloride, $CaCl_2$.—This substance is obtained by dissolving calcium carbonate in hydrochloric acid and evaporating the solution; it occurs usually in moist transparent colourless crystals, $CaCl_2 + 6H_2O$; when heated much of this water of crystallisation is evolved, and the residue, termed fused calcium chloride, is often used as a drying agent.

Calcium Sulphate, $CaSO_4$, occurs in France, etc., in colourless crystals, as "gypsum," and in an opaque compact form, somewhat resembling marble, as "alabaster." These substances are much softer than marble, and can be scratched by the thumb-nail: they contain two molecules of water of crystallisation. $CaSO_4 + 2H_2O$. When gypsum is heated, it gives off these two molecules of water and crumbles to a fine powder, forming "plaster of Paris." When this plaster of Paris is mixed with water, it recombines with the two molecules of water, re-forming gypsum. When heated with charcoal, calcium sulphate is converted into calcium sulphide; this substance has the peculiar property of becoming luminous in the dark after it has been exposed for a short time to a bright light; it forms the basis of the well known luminous paint.

LATIN.—XXV.

[Continued from Vol. IV., p. 327.]

ORATIO OBLIQUA (continued).

§ 35. THE following passage will require still more care in translation; in particular, we must carefully discriminate between the narrator's own words and the words or thoughts of the different actors in the episode narrated. The notes appended should be thoughtfully studied:—

The supreme command was unanimously assigned[1] to Cortes. While a few of them were discussing[1] their condition in private, one of the Spanish nobles told them that it was useless for them to cling to[2] utterly ruined hopes; victory was despaired of, and given up for lost; there were even some of the young nobles, with Dom Pedro at their head, who were thinking of making for the ships and flying home across the sea. He proposed[3] that a council should be summoned to consider the situation.[4] But Cortes declared that it was no time for a council. They must do and dare. In such calamities it was not deliberation that was wanted. "Let all," he cried,[5] "who wish to secure their safety put on their arms without delay, and come with me."

Followed by a few of them, he went straight to Pedro's tent, and found there the gathering of young nobles of whom he had heard. Drawing his sword over the heads of the conspirators, he declared[6] it was his fixed resolve not to abandon the expedition, and not[7] to suffer any other Spaniard to abandon it. "If wittingly I break this resolution, may the almighty and merciful God smite me, my family, and my possessions with utter destruction!" This oath he insisted that Dom Pedro and all present[8] should take after him. Whoever did not swear must know that that sword was drawn against him. In as great alarm as if they saw before them the victorious Montesuma,[9] they swore to a man, and delivered themselves into the custody of Cortes.

NOTES.

[1] If "unanimously" be rendered "by the agreement of all," we shall be able to continue the narrative by the relative connection, which is so very favourite a one in Latin; and, "while . . . discussing . . . told them," will be "to whom . . . discussing . . . told."

[2] *Cling to.* One of the innumerable metaphors in English, for which the Latin equivalent will probably be different and simpler.

[4] *The situation.* Say "what they ought to do," or some such verbal clause; or simply "concerning that"; or else use *res*—a word which has been styled a "blank cheque", being capable of almost any value, and deriving its particular meaning from the context. Most languages have some such words, of vague but expansive significance; and Latin, in spite of its general and most characteristic precision and definiteness (leaving little to the imagination), is no exception. We use "*things*" and "*the matter*" in much the same way: *e.g.*, "how *things* are going," "the state of *things*," etc.

[5] Such a sudden return to *Oratio Recta* for a single short emphatic sentence, though very common in English, is not usual in Latin. It should never to employed in Latin, as it is farther on in this passage in English, without the verb of saying to introduce it. (The verb used in such cases to introduce the precise words of the speaker is *inquit*, which stands alone in the middle of the sentence—like our "he says," "says he"—after the first emphatic words or convenient pause. It must be noted that it always stands alone; if there be any subject, with adjectival adjuncts, or any adverbs to be expressed, they must be placed at the beginning of the sentence, broken off as it were from the construction: *e.g.*—Tum consul impavidus, qui nullum periculum timeret, summa cum fortitudine, "Nunquam," inquit, "vivus tibi manus dabo.") Here it will be better to continue the *Oratio Obliqua*.

[6] It will be useful practice to express the whole of this speech down to "drawn against him", in *Oratio Recta*. It is quite usual in Latin to pass from *Obliqua* to *Recta* in the report of a longer passage.

The first two sentences in this paragraph should be thrown into one period in Latin, the main clause

being what he said, and the others duly subordinated to it, in accordance with the Latin tendency noted in § 14, and below.

[7] *Not to abandon . . . and not to suffer* . . . We have here a characteristic difference between the two languages—another example of the Latin desire to bring everything as much as possible into the compass of a period, to "focus" the whole thought at once, and gain a survey of it all (if one may say so) at a single glance. In English, if we have two co-ordinate thoughts, parallel as it were with one another, we commonly express them by two co-ordinate sentences united together by the simplest co-ordinating conjunction, and are not conscious of any unpleasant effect in so evidently natural a mode of expression. But in Latin, the second clause—if such a mode of expression were adopted—would seem to straggle after the first, and to drag behind in an unpleasant and awkward fashion.

Latin, therefore, always brings such sentences into "focus", and immediately "points", the expression, and marks the co-ordination and parallelism, by the use of two corresponding demonstrative adverbs or conjunctions (*e.g., ut . . . ita, cum. . . tum, tam . . . quam*); or else, if the thought admits of such a turn, actually subordinates one clause to the other.

So here the speaker would say, "*As* I will not abandon . . . *so* I will not suffer . ." Such a mode of turning the sentence is used, for instance, in relative co-ordinate sentences—*e.g.*, "who did this . . . and who . ."

[8] *All present* must be expressed in Latin by a relative clause. (*Vide* below on the use of Participles in Latin.)

[9] *Cortes, Dom Pedro, Montesuma.* Names like these might easily be Latinised, but it will usually be better to choose some appropriate Latin name, instead of troubling to invent a Latin form of foreign ones. But to choose appropriate equivalents will require some knowledge of Roman history. Here we need for "Cortes" some Roman conqueror of foreign countries; for "Pedro," some timid dissatisfied contemporary; for "Montesuma," some dreaded enemy of Rome. If we are to express Pedro's title, it must be by some phrase in apposition—such as "vir consularis," or "vir equestri ordine," or "vir illustris," and so on, which will follow the proper name.

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§ 36 The Period.

We have already spoken of the period as one of the chief characteristics of the Latin prose style, and we have noticed a few instances of it, and of the influence upon Latin modes of expression and the structure of Latin sentences exerted by the inherent tendency to the periodic form of expression—the influence, that is, of the wish to be able to see as much as possible at a glance, to say as much as possible in a single utterance, and (by an elaborate system of subordination and careful grouping of accessory clauses around one which conveys the main thought or fact) to set in the clearest possible light the logical relation of each section of the expression to the whole.

Of course the period is not always to be used, and, as we have noted incidentally, never when the different sentences which would be thus blended together are really independent, or some of them specially emphatic, unless, as is often done, these are worked into the period as parentheses. Moreover, the steadiness and evenness of its flow, the demand it makes for sustained attention, and the command of emotion and balance of thought which the use of so complex a mode of expression implies, render it evidently unsuitable to be the vehicle of agitated feelings, of anger or passion of any kind, of rapid incisive argument, or sudden transitions of thought. There is also something too elaborate in the picture it presents for common use in daily life, and Romans did not talk together in periods, nor use them in their correspondence to their friends. If they had done so, they would have exposed themselves to the criticism of our homely phrase, and might have been said to talk or write "like a book."

Quiet, easy-flowing description, that does not aim at too vivid or startling pictures, and steady narrative—this is the sphere of the periodic style. Whenever the description or narrative becomes exciting, there will come in, and take the place of the period, the detached style of shorter co-ordinate sentences, and the co-ordinating conjunctions (by which Latin sentences are invariably connected, thus differing from the entirely unconnected sentences which make up some of the best English prose) will disappear.

Thus, no style of composition—historical, narrative, philosophical, oratorical, epistolary, conversational—has an entire monopoly of either the periodic or the detached style of expression: each will be found in its appropriate place, with its appropriate subject-matter; though it is quite clear, from what has been said, that the period will occur much more frequently in the first three styles enumerated above than in the last three, and most frequently of all in the purely philosophical style (except that the last, when it is cast in the dialogue form, assumes an ornate and elaborate conversational form).

The order of the subordinate clauses in the

period will often at first sight be a difficulty. They must be arranged in the order of logical sequence, and every sentence must begin with the word in it which stands in closest connection with the preceding sentence. As has been already mentioned, the rules of order in simple sentences apply equally to compound sentences and to whole periods; each of the various subordinate clauses will be grouped, according to those rules, round that constituent of the principal clause with which it is most closely connected in thought.

Subjoined are some English passages for translation into Latin. The student must decide for himself in each case whether the detached or the periodic style will be most appropriate. He is recommended to carefully re-read the sections on Order (*supra*, §§ 12, 13).

§ 37. Exercises on Periodic and Detached Styles.

(1) Gisco was hastily summoned. Hanno pointed to the almost lifeless body of the man, and, seizing his hand, implored him not to leave his father unavenged, and not to let himself be the laughing-stock of his enemies. The kingdom was Gisco's, if he was a man, he cried; they who had done that foulest of crimes by the hands of others, had no claim to it. Let him nerve himself to the work, and follow the leading of the gods, who prophesied renown for him of old by the supernatural fire which played around his head. Such a celestial flame ought to inspire him now; he ought to arouse himself in earnest, and consider his present capacities rather than his birth; and if through the suddenness of the occurrence he was slow in forming his own plans, he should surely act upon his.

(2) In the same year died Q. Fabius Maximus, at a good old age; at least, if it is true—and some vouch for the fact—that he had been an augur for over sixty years. He was undoubtedly worthy of the title "Great," even if it was applied to him for the first time. He surpassed his father, and equalled his grandfather in his distinctions. The fame of his grandfather Rullus rested on greater battles and more numerous victories, but a single enemy —Hannibal—can count as many as all of them. Fabius was more careful than daring by nature; and if anyone is inclined to question whether he was naturally a "procrastinator," or only because such a policy was peculiarly adapted to the war which was then being fought, it is, at all events, absolutely certain—in the words of Ennius—that "one man by his procrastination restored the fortunes of Rome." His son, of the same name, was installed as augur in his place, and Servius Sulpicius Galba as pontifex, for he held the two priestly offices.

§ 38. The Period: Participles.

We have already noticed incidentally the extent to which Latin makes use of the participle, where in English we should substitute for it either a co-ordinate clause, introduced by one of the co-ordinating conjunctions, or a subordinate clause, introduced by an adverbial conjunction or the relative.

In building up the Period, Latin makes, of course, large use of the adverbial conjunctions, especially of the causal and temporal conjunctions; but the manner in which it employs the participle is one of its most characteristic idioms, and as such is worthy of the careful attention of those whose language does not admit of the same freedom of use. The Latin participle is often most idiomatically rendered into English by an adverbial or relative clause. We must be prepared to adopt the Latin equivalent idiom in our translations from English into Latin, and so express two or more clauses of English by a single clause of Latin.

In some respects, however, English is laxer in its use of participles than Latin; and the following general rules for the use of the participles in Latin may be laid down.

(1) Present Participle Active.—The Latin present participle is not so freely used as in English. It is always strictly present, and denotes action contemporaneous with the time of the verb whose subject or object it qualifies.

English participles which, with the careless use of tenses characteristic of English, are present in form, must often be translated by past participles in Latin, or some equivalent temporal clause: *e.g.*, "Hearing this, he at once set out for Rome," must be in Latin, "*Hoc audito* or *cum haec audivisset* ad urbem statim proficiscitur."

Again, many participial phrases in English are really elliptical, a pronoun or a relative and an auxiliary verb being omitted. To translate such constructions word for word into a language which does not use its auxiliaries in the same way, would naturally result in confusion and absurdity. We must, therefore, in all such cases aim at translating the idea rather than the actual words. At the worst, we must translate the full English construction, and not the idiomatic elliptical abbreviation of it: *e.g.*—

While talking to me, he suddenly saw him = *While he was talking* . . .

When disembarking from the ship, he fell into the water = *When he was disembarking* . . .

Those surrendering at once shall return to their homes in safety = *Those who surrender* . . .

And the Latin equivalents would be :—

Dum mecum colloquitur subito eum vidit.
Cum e nave descendebat in aquam cecidit.
Ei qui manus statim dant domum incolumes redibunt.

But the present participle is often used *in the oblique cases*—especially in the genitive and dative plural—to denote *classes* of persons : *e.g.*—

There was no dearth of tales from the critics.
Non deerant sermones *increpantium*.
Be gracious to those who wish you well
Benevolentibus indulge.

(2) Present Participle Passive.—Latin having no present participle passive, is obliged to use instead a relative clause : *e.g.*—

The besieged.
Qui ab hoste *obsidentur*.
The despised can often do harm.
Qui contemnuntur saepe nocere possunt.

(3) Past Participle Active.—Latin has this only in the case of deponent verbs. The English past participle active will, therefore, in all other cases be represented by a subordinate adverbial or relative clause, or often by the use of the past participle passive in agreement with the object of the participle active of English : *e.g.*—

Having conquered the enemy, he killed them all.
Hostes victos (*or* quum vicisset) omnes interfecit.

(4) Past Participle Passive.—The past participle passive is constantly used in all cases in Latin, and is often represented by a co-ordinate clause in English : *e.g.*—

Victus fugit.	He was conquered, and fled.
Damnatum occidunt.	They condemned and killed him.

(5) Ablative Absolute.—The use of the ablative absolute (*i.e.*, a participle and noun in agreement in the ablative case, standing outside the rest of the clause in construction) is one of the commonest of all the participial constructions of Latin, and should be especially borne in mind as one of the readiest means of obtaining the periodic style of narration. A writer like Cæsar rather rides it to death; but a judicious use of it will enable us to overcome many difficulties of English construction and phrase, and to secure (in combination with conjunctional clauses) that variety on which—especially in a long period—grace of style so much depends. It will also constantly be the most idiomatic way of rendering English prepositional and noun phrases (especially the verbal nouns in *-ing*), Latin—as we have noticed—preferring the personal and verbal constructions to the use of abstract nouns, unless, indeed, the idea be really and strictly abstract.

The case-usage in this construction is that which expresses the "attendant circumstances" of the action of the main verb, whether of *condition*, *limitation* or *contrast*, *cause*, or *time*. The *tense* of the participle will be *present* if denoting time contemporaneous with, or *past* if denoting time prior to, that of the principal verb.

The student should carefully notice one limitation to the use of this construction, though at this stage in his course it need hardly be pointed out. The ablative absolute construction, of course, cannot be used of the subject or object of the principal verb. We cannot say, *e.g.*, "Me absente ab omnibus laudatus sum," or "Mortuo Clodio nemo non eum increpuit." The participle must, of course, be in agreement with the subject or object; and we must write for "me absente" simply *absens*, and for "mortuo Clodio . . . eum" simply *Clodium mortuum*.

KEY TO EXERCISES.

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Ex. § 31. (*a*) (Dixit eos) juvenem flagrantem cupidine regni ad exercitus misisse. Aluisse ergo illud incendium quo nunc arderent. Saguntum circumsedere exercitus eorum, unde arcerentur foedere; mox Carthaginem circumsessuras (esse) Romanas legiones, ducibus eisdem deis, per quos priore bello se sint ulti.* Utrum hostem an semet ipsos an fortunam utriusque populi ignorarent? Legatos imperatorem eorum in castra non admisisse; jus gentium sustulisse; illos tamen ad se venisse; ut publica fraus abesset, auctorem culpae deposcere. Quo lenius agerent, eo, cum coepissent, vererise, ne perseverantius saevirent. Aegates insulas ante oculos proponerent, quae terra marique passi essent. Nec puerum illum ducem fuisse, sed patrem ipsum Hamilcarem, Martem alterum, ut illi vellent . . . Sagunti ruinas (falsus utinam vates essem) suis ipsorum capitibus incasuras, susceptumque cum Saguntinis bellum habendum cum Romanis esse. Dederentne ergo Hannibalem? rogaturum esse aliquem. Scire suam levem esse in eo auctoritatem; sed et Hamilcarem eo perisse laetatum esse, quod, si ille vixisset, bellum jam tum habuissent cum Romanis, atque illum juvenem tanquam furiam facemque ejus belli odisse ac detestari; nec dedendum solum ad piaculum rupti foederis, sed, si nemo deposceret, ablegandum eo, unde nec ad se nomen famaque ejus accidere neque ille sollicitare quietae civitatis statum posset.

(*b*) (Dixit) rem omnes sibi cum illo esse. Dicturum aperte. Si illum secum dicendo ac diluendis criminibus in ea causa contendere putasset, se quoque in accusando operam consumpturum fuisse.

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Ex. § 32. (*a*) Senatum obtestor, ne Romanum cum Saguntino suscipiant bellum; monui, praedixi (ego), ne Hamilcaris progeniem ad exercitus mitterent (*or* mitteretis)! Non manes, non stirps ejus conquiescunt viri, nec unquam, donec sanguinis nominisque Barcini quisquam superest, quiescent Romana foedera.

(*b*) Haec tamen dicimus. Venimus inviti, ejecti domo. Si nostram gratiam Romani volunt (*or* vultis), possumus eis (vobis) utiles esse amici. Vel nobis agros attribuant (attribuite), vel patiantur (patimini) eos tenere quos armis possedimus. Uni Suevis concedimus, quibus ne dî quidem immortales pares esse possunt : reliquus quidem in terris nemo est, quem non superare possumus.

* Primary tense instead of secondary, for greater vividness, as in many instances in the passages in § 32 *infra*.

(c) Tempus jam adest, ut hostem vincatis, vobisque opes gloriam, quam victi nuper amisistis, iterum recuperetis. Suo quisque duci libenter pareat, et signa impavidus sequatur.

(d) Habetis milites, quam petistis facultatem. Hostem impedito atque iniquo loco tenetis. Imperatorem adesse existimate.

(e) Militi quidem armato quid invium aut inexsuperabile est? Saguntum ut caperetur, quid periculi, quid laboris exhaustum est? Romam, caput orbis terrarum, petentibus quicquam adeo asperum atque arduum videtur, quod inceptum moretur? Ceperunt quondam Galli ea, quae adiri posse Poenus desperat! Proinde aut cedite animo atque virtute genti per hos dies toties a vobis victae, aut itineris finem sperate campum interjacentem Tiberi ac moenibus Romanis.

p. 326.

Ex. § 34.—Ceterum nemini omnium major justiorque quam ipsi consuli victoria videri; gaudio efferri, qua parte copiarum collega victus esset, ea se vicisse: restitutos ac refectos militibus animos, nec quemquam esse praeter suum in imperio collegam qui dilatam dimicationem vellet; eum, animo magis quam corpore aegrum, memoria vulneris aciem ac tela horrere. Sed non esse cum aegro senescendum. Quid enim ultra differri, aut teri tempus? quem tertium consulem, quem alium exercitum exspectari? Castra Gallorum in Italia ac prope in conspectu urbis esse. Non Siciliam ac Sardiniam tum peti, sed solo patrio terraque, in qua geniti essent, pelli Romanos. Quantum ingemiscerent majores sui, si viderent progeniem suam, duos consules consularesque exercitus, in media Italia paventes intra castra, Gallum, quod inter Alpes Apenninumque agri esset, suae potestatis fecisse! Itaque, nequicquam dissentiente aegro collega, patri ad propinquum certamen milites jubet.

HISTORIC SKETCHES, GENERAL.—V.

[Continued from Vol. IV., p. 331.]

THE ITALIAN REPUBLICS.

THE existence of the Italian Republics is one of the most curious facts of the Middle Ages. When it is considered that until a comparatively recent time, republican institutions were nowhere tolerated, and that in what we are pleased to call the Dark Ages the one-will system of despotism was all but universal, it is matter for wonder that in the very centre of the civilised world there should have been suffered to grow up and to flourish states founded upon universal suffrage, institutions which lacked in every particular, even in the matter of order, the elements of public policy which were in common use throughout the known world.

DEFEAT OF THE GENOESE BY THE VENETIANS.

Yet the many independent tiny states which sprang up in Italy about the beginning of the tenth century, and multiplied, replenishing the earth immediately around them, and subduing it until the end of the twelfth century, answered exactly to this description. They were the outcome of decaying princely imperialism, which was not strong enough to crush out their life; they were the vanguard against nascent priestly imperialism, which failed to thrive so long as they stood true to themselves and to the principles on which they were founded.

It may sound strange, but imperial Rome herself was the example by which the republics guided themselves; in this, as in other matters, she was the model for the world. After the departure of the emperor and the government to Constantinople (A.D. 334), the Romans, left to themselves, had to improvise a ruling system, and to organise the means of resistance to those external foes who

daily threatened to destroy the empire, and who did, in fact, again and again come down in force upon its frontiers and offer violence even to the Eternal City. The Romans accordingly turned back to an old page in their history, and deeming that the past republican times were those of greatest strength and glory, moulded their new government upon the old, and for a while presented the spectacle of democratic institutions in the very cradle of despotism. They were not strong enough, not united enough, to establish themselves permanently on this basis, and in a very short time their bishop, who had been invited to take a share in the government, acquired royal prerogatives in it, and subverted republicanism while retaining the form of it. Whether but for this the Romans would have preserved their independence it is hard to speculate, impossible to say; the German emperors and French kings were too much interested in possessing her, and in winning the prestige which possession of Rome gave, to allow her to remain in peaceful enjoyment of independence; but she set the example which was largely followed by cities of less seeming importance than her own—she was the model on which were founded the mediæval Italian Republics.

It may be as well to mention here how Italy came to be under the dominion of the French emperors—a dominion from which she emerged into the republican phase of her existence. After the decline of the Western Roman empire at the end of the fifth century, eight Gothic kings in succession held sway over Italy, but the last of these being expelled in the year 553 by Narses, acting in behalf of the Greek emperor, the southern portion of the peninsula reverted to the imperial rule, while the northern part remained under the kings of Lombardy. Over districts of the recovered south the Greek emperor appointed governors, called exarchs, the chief of whom had his seat of government at Ravenna; and these viceroys held a sort of authoritative place for over a century and a half, the Bishop of Rome having equal authority with them, or rather superior power, for half-savage princes in the north, who paid no attention to, showed no respect for the imperial lieutenants, forbore at the bidding of the Roman bishop to use that violence they did not scruple to show to the arm of flesh that pretended to hold them off. Time, however, wore off the fear which belief or superstition inspired, and Lombard kings began at last to think that ecclesiastical princes were no more to be respected than lay princes, seeing that they combined the secular element with the clerical in a union that admitted of no distinction between themselves and others. About the year A.D. 712, therefore, Luitprand King of Lombardy began to turn his attention southward, and was only dissuaded by the strongest solicitations of the Pope from sacking the city of Rome. Forty years afterwards, his descendant, Astolphus, urged by suggestions of conquest, was undeterred even by religious considerations, and was only kept at bay by the intervention of foreign arms. The Greek emperor having been appealed to in vain—the exarchate of Ravenna had already fallen—the Pope applied to the Frankish emperor, the most powerful prince in Western Europe, for assistance. Pepin the Short quickly responded to the invitation, and the mere terror of his threats kept the Lombard hands off. Desiderius, the son of Astolphus, however, relieved by the great monarch's death from the dread of immediate danger, led an army to the south, and intended to acquire for himself the Eternal City. Charlemagne, the successor of Pepin, anxious to obtain for himself recognition as the arbiter in Italy, and solicitous also of acquiring the imperial dignity, listened attentively to the requests from the Pope; and when Desiderius grew troublesome, and actually set out for Rome, he put himself at the head of a considerable army, and, descending from the Alps, hurled the Lombard back into his kingdom in the north. Charlemagne retiring, Desiderius returned, and once more drew the French emperor from his transalpine seat. Desiderius was overthrown with great loss; the Frankish army marched to Rome, and its leader received from the hands of the grateful Pope the imperial crown, with all the sanction that priesthood in a superstitious age could confer. A similar title had been freely granted to Pepin, but Charlemagne was the first to acquire it to the full extent. Italy passed under Frankish dominion, but Rome, with its bishop, obtained special terms; and the bishop obtained more special terms still for himself, being raised to the dignity of a temporal as well as spiritual prince, independently of the Roman people and of the emperor who was supposed to rule over them. For a century this state of things continued, the Popes getting increased power as the power of the emperors declined, till the death of Charles the Fat, when the political confusion mentioned in this article caused the Popes to be left to their own devices, and the supremacy in Northern Italy to be disputed among the satraps of the empire.

When Charles the Fat, last reigning monarch of the House of Charlemagne, died in the year 888, Italy, which was included in his empire, was parcelled out among a few nobles who had gradually arrogated to themselves royal powers. They had taken advantage of the impotence of the last Carlovingian kings to carve out for themselves

kingdoms over which they ruled with an authority that admitted of no appeal. They paid nominal obedience to the French king, but in reality never heeded the least of his commands. Chief among them were the Dukes of Tuscany and Spoleto, the Marquises of Ivrea, Susa, and Friuli, and the Lord of Benevento. Ten years of internecine war and of striving for the mastery ended in the coronation of Guy Duke of Spoleto, not as emperor, but as lord over his brethren in the northern part of Italy. Then came war again, bitter and disastrous; there was no one to strike in and to restore order with supreme authority, and in the end there happened what must always happen when co-equals are pitted against one another—a third person was called in, who suppressed the wranglers. In the year 962, Otho the Great, Emperor of Germany, was elected by general assent to take the place for which the Frankish monarchs were proved to be inadequate. He received the allegiance of the West, and conceding to the Pope something more than he had already acquired, won the support of that prelate, while he at the same time assisted to build up the edifice of priestly power that afterwards became so great, overshadowing even the imperial force that made it. Of course the emperor, ruler of so vast a domain as he was called to govern, could not have an equal eye to all his subjects; he was unable to rule in his elective foreign states as in his own home territory, and there was, moreover, in the former an element of disunion which militated strongly against any idea of universal comprehension. There was in the Italian districts, especially in the cities, a spirit of resistance to German domination quite equal to that which has characterised Italians in the present day; there was in the Italian mind a consciousness of superiority which no amount of brute force could overcome; and there was also a determination to make this consciousness apparent in every possible way.

Under these circumstances it was that the Italian Republics, so famous in the history of arts, literature, and commerce, sprang into being and entered upon a career which was more or less glorious, until selfishness asserting itself, and treachery becoming rampant, reduced them into a final state which was worse than the first. "It is impossible," says Hallam, "to ascertain the time at which the cities of Lombardy began to assume a republican form of government, or to trace with precision the gradations of their progress." But it may be stated generally that about the end of the tenth century republicanism began to find expression in the cities of Northern Italy. Milan, if not the earliest, was the first important city which made itself independent. It not only maintained itself against imperial tyranny, but repelled (as in the year 991) the insolence of priests by expelling its archbishop. Milan, as the centre of Lombardy, and as the seat of government under the Lombard kings, had a prestige and a vantage point which were lacking to the other cities, and when it came to be a question of the cities making head against king, emperor, or pope, Milan was naturally looked to as the leader in the struggle, and quite as naturally accepted the post. It was Milan that, in the year 1167, organised the League of Lombardy against the Emperor Frederic Barbarossa, and after suffering enormously from the brutality as much as from the power of his attacks, succeeded in extorting from him, after his overthrow at the battle of Legnano, the Peace of Constance, whereby the cities in the league were maintained in the enjoyment of all the royal rights, whether within their walls or in their district, which they could claim by usage. The right of levying war, of raising fortifications, and of administering justice were specially conferred, together with the right to elect magistrates; while the emperor was allowed to retain one or two privileges which denoted his superiority, and was to receive an oath of allegiance from the cities every ten years. But for jealousies which sprang up in all directions, the Lombard cities might have established once and for ever a federal union which would have defied all external powers whatever. Jealousy, however, entered to a most injurious extent, and the result was a never-ending series of wars and rivalries which on several occasions gave emperor, duke, and count an opportunity, of which they availed themselves, to step in and take revenge for past slights.

The great republics, besides the republic of Milan, were those of Genoa, Florence, Pisa, Cremona, Pavia, Parma, Lodi, Alessandria, Verona, Padua, Bologna, Ferrara, and Faenza. Later on, Venice, more famous than any of them, rose into power, but under different circumstances and with different interests. One form of government seems, with slight modification, to have been general to all the earlier republics. By universal suffrage one or more consuls were elected to preside over the council of safety, a sort of ministerial committee chosen by the people and charged with the actual government. The consuls were appointed annually, and were invested with large powers, but were not made absolute except in case of war, when they were in the nature of dictators for the time being. The abuse of power by these rulers, or, perhaps, rather the jealousy of natives, who misliked that one family or one man, where all were equal, should be so greatly in the ascendant,

led, about the end of the twelfth century, to the institution of podestas, as they were called: that is to say, governors selected from some family of known eminence in Italy; it might be in the neighbourhood, it might be at the other end of the peninsula. The podesta acted as general, criminal judge, and preserver of the peace. The proper discharge of the duties of this office required a man of no ordinary power, and demanded above all an upright and clear-minded man. It was manifestly difficult for any native citizen to exercise such power; the foreign element was found to be most advantageous, as avoiding favouritism, and the danger of tyranny on the part of the podesta was avoided by making his office an elective one, and tenable for a year only. It was the business of the podesta to lead the forces of the republic, to act as general in the field, and as negotiator after the battle. He was more or less absolute.

It is evident that such a power as this was likely to be abused, and in effect there grew out of it those oppressive dominations by powerful families which caused so much jealousy and so much suffering, and which ended in the ruin of the republics. As time went on, men were chosen for podestas who had signalised themselves in some especial manner in respect of some of the special attributes of a dictator, and as war was one of these, it followed that men were chosen who were skilled in the military art. Such men were the commanders of the mercenary foreign troops who made war a trade, and sold their services to the highest bidder. Once elected to fill a civil and military post, these men filled it in a way wholly military, and established a despotism backed by professional force which no citizen power could withstand; *coups d'état* followed, and then hereditary tyranny, till at last the spirit of freedom which erst prompted the foundation of little states was entirely crushed under a vulgar and more soldier rule. Thus the house of Sforza came to rule for years in Milan, and thus other names equally well known in Italian history came into notoriety. In some cities the same thing happened at the hands of native citizens, and men like the Medici at Florence, the Doria of Genoa, the Malatesti of Rimini, and, after the downfall of Sforza, the Visconti of Milan, rose into a power which was not far short of that enjoyed by princes. Popular government was of course quite incompatible with this state of things; the people passed under the yoke from which their forefathers escaped, their only satisfaction being that their tyrant was one of themselves and within reach.

All the larger republics held, by treaty or conquest, districts of land and cities apart from their own. Tribute, contributions of men and material, were exacted from these, and in war time they suffered all and more than the hardships borne by the owning republic. Sometimes they were a source of weakness, choosing the time of their master's trouble to pay out some ill will and to requite some oppression; but generally the deterring influence of fear of punishment after the war kept them loyal—in deed, at all events. The civil and foreign wars endured by the republics were continuous, and when very bitter, ruinous. This was the case with the wars between Genoa and Venice, until the latter prevailed in what proved to be at once a fatal struggle for Genoa, and one from which the other state emerged stronger than before. In 1378, Venice, which by her wealth and power had excited the cupidity and envy of other republics, drew down the united forces of Genoa, Padua, and Hungary upon her. The Genoese admiral, Doria, blockaded the city with a fleet of which the strength seemed overwhelming; distress made Venice ask terms of peace, which were refused by Genoa; and the ambassadors who went to sue returned to Venice with the assurance that there should be no peace till the allies had put a curb "in the mouths of those wild horses that stand upon the place of St. Mark." Desperate men do desperate things; and the Venetians, under the conduct of their admiral, Pisani, thereafter attacked the Genoese, and fought so well that they destroyed the enemy's fleet, and compelled the Genoese to fall back upon their allies in order to save themselves from annihilation. From this time Genoa declined in power, and Venice began to acquire it. For the moment, Venice had to make concessions to the King of Hungary and the Lord of Padua; but she grew yearly in strength, and the time came when she reduced Padua to the condition of a dependency, and made the Hungarians anxious to secure her alliance. Long after all the other republics had been overthrown, or absorbed in the territory of some grand duke, Venice remained, for wealth and influence, one of the most important states in Europe. Though shorn of much splendour, stripped of almost all her mainland territory, and no longer the entrepôt for commerce between Europe and the East, she continued to elect her doge or head magistrate every year, and to preserve a kind of independence, until Napoleon Bonaparte executed the threat of the Genoese admiral, and put a bridle in the mouths of the horses of St. Mark. In 1797 the Republic of Venice ceased to exist, and in 1814 was by treaty embodied in the Austrian Empire, a disposition which, though familiar enough historically to all the other republics, was as utterly

unknown historically as it was uncongenial to Venice. Hence the deep hatred, deeper than in Milan or other Lombard cities, felt by the Venetians for the Tedeschi during the whole period of occupation; hence the delight with which, after the battle of Sadowa, the Venetians found that the restoration of their city to Italian hands was one of the articles in the Austro-Prussian treaty of peace. For the rest, the many other republics to which allusion has been made herein fell one by one under the authority of a few of the strongest among their brethren; and these again, as the progress of larger kingdoms in the west and north became more marked and their condition more settled, were found to be incompatible with the new order of things, and were accordingly taken to form parts of grand duchies (for the most part under German grand dukes), till these again fell to pieces under the disintegrating Italian policy of Napoleon III., and became, after Magenta and Solferino, part and parcel of the present kingdom of Italy.

See:—Hallam, Middle Ages; Cassell's Universal History.

ELECTRICITY.—IV.

[*Continued from Vol. IV., p. 336.*]

REQUIREMENTS OF A GOOD CELL—CLASSIFICATION OF CELLS—CRUIKSHANK'S BATTERY—WALLASTON'S BATTERY—CONSTANCY OF A POLARISED CELL—THE SMEE CELL—THE GROVE CELL—THE BUNSEN CELL—THE BOTTLE BICHROMATE—THE TROUVÉ CELL—FULLER'S BICHROMATE.

A GOOD primary battery should fulfil as many as possible of the following conditions:—

1. Its electromotive force should be high and constant.

2. Its resistance should be low and constant.

3. It should be free from polarisation.

4. There should be no consumption of materials when the cell is not in use.

5. The materials should be inexpensive and durable.

6. It should not require frequent renewals of either aliment or depolarising agent.

7. It should not emit either noxious or corrosive fumes.

No single cell possesses all these qualifications, though many possess several of them in a very marked degree. For any particular class of work it will always be found that one type of cell is more suitable than any other, which is a necessary consequence of the fact that our ideal perfect cell has not yet been constructed.

CLASSIFICATION OF CELLS.

In order to obtain a high E.M.F., and consequently a strong current from a cell, polarisation must be either entirely eliminated, or reduced to the smallest possible amount. Numerous remedies have been adopted for getting rid of polarisation, and though these remedies differ in detail, each depends on some one of three general principles. The methods adopted for preventing polarisation supply us with the most convenient, and probably the most accurate system for classifying cells. According to this system cells may be divided into the following four classes:—

I. Those in which no attempt is made to prevent the phenomenon of polarisation.

II. Those in which polarisation is prevented by mechanical means.

III. Those in which polarisation is prevented by purely chemical means.

IV. Those in which polarisation is prevented by electro-chemical means.

CLASS I.

The zinc and copper cell which has been fully described in the last chapter is the typical cell of this class. The original "pile" constructed by Volta in 1799, and known as the "Voltaic pile," also belongs to this class; this pile possesses a large amount of historical interest, but as it is of very little practical use, it is scarcely necessary to describe it in these lessons.

Cruikshank's Battery (1801).—The battery illustrated in Fig. 4 is nothing more than a convenient method of grouping a number of single cells

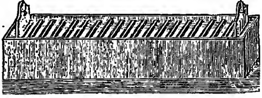


Fig. 4.—CRUIKSHANK'S BATTERY.

in series. It is made up in a long wooden trough which is divided up into a number of compartments by means of rectangular copper plates; a sheet of zinc is soldered to each copper plate, and the compartments are then filled with dilute sulphuric acid. A single plate of copper (Cu), plunged into the acid at one end of the battery, and one of zinc (Zn) at the other end, form respectively the positive and negative terminals.

This battery has a moderately low internal resistance, but it quickly polarises. When the battery is not in use, all the acid should be poured out, in order to prevent the zinc being eaten away

by the local action which cannot altogether be prevented.

Wallaston's Battery (1802).—This battery is but

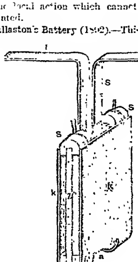
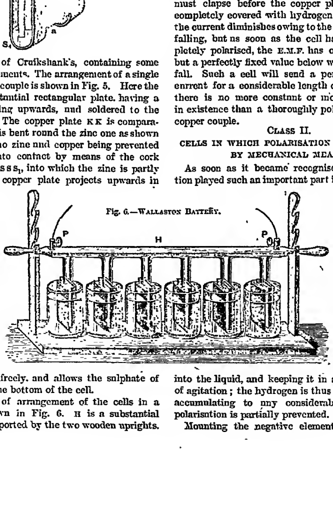


Fig. 5.

a modification of Cruikshank's, containing some distinct improvements. The arrangement of a single zinc and copper couple is shown in Fig. 5. Here the zinc Z is a substantial rectangular plate, having a portion projecting upwards, and soldered to the copper band I. The copper plate K K is comparatively thin, and is bent round the zinc one as shown in the figure, the zinc and copper being prevented from coming into contact by means of the cork distance-pieces S S S_1, into which the zinc is partly inserted. The copper plate projects upwards in the form of the band I, which is convenient either for forming the terminal of the cell, or for connecting to the zinc of an adjacent one where a number of cells are used. The copper plate is cut away at *a*, which allows the acid to circulate more freely, and allows the sulphate of zinc to fall to the bottom of the cell.

Fig. 6.—Wallaston Battery.



The method of arrangement of the cells in a battery is shown in Fig. 6. H is a substantial wooden bar supported by the two wooden uprights. All the zincs and coppers are bolted to the under-surface of this bar by means of the copper connecting bands, so that by raising the bar the metals can be withdrawn from the liquid—this is always done when the cells are not in use, it saves the trouble of re-filling the cells each time they are used. The reservoirs are made either of glass or porcelain, and contain dilute sulphuric acid as the aliment. The terminals are marked *p p*. The bent form of the copper plate halves the resistance of each cell by doubling the effective surface of the copper—this device is adopted in some of the most modern cells. Like all cells of this class, the Wallaston quickly polarises, but, notwithstanding this fact, it can send a strong current owing to its small resistance.

Constancy of a Polarised Cell.—It is very often supposed that a cell which polarises is incapable of generating a constant current, but no greater mistake could be made. During the time which must elapse before the copper plate has become completely covered with hydrogen, it is true that the current diminishes owing to the E.M.F. gradually falling, but as soon as the cell has become completely polarised, the E.M.F. has obtained a small but a perfectly fixed value below which it does not fall. Such a cell will send a perfectly constant current for a considerable length of time; in fact, there is no more constant or more reliable cell in existence than a thoroughly polarised zinc and copper couple.

Class II.

CELLS IN WHICH POLARISATION IS PREVENTED BY MECHANICAL MEANS.

As soon as it became recognised that polarisation played such an important part in the action of a cell, numerous mechanical devices were adopted in order to prevent the accumulation of hydrogen on the negative element. Amongst these devices the following met with some measure of success:—

Blowing air into the liquid, and keeping it in a constant state of agitation; the hydrogen is thus prevented from accumulating to any considerable extent, and polarisation is partially prevented.

Mounting the negative elements on a spindle

which passes through their centres, and which, when the cell is in action, revolves so as to allow only half of each plate to be in the liquid whilst the other half is passing through the air. In such a cell, the hydrogen which is deposited on that portion of the plate which is immersed, unites with the oxygen of the air to form water as soon as it leaves the liquid; each portion therefore of the plate returns to the liquid with but little hydrogen on its surface. Cells of this kind are expensive to maintain, and are not very satisfactory in their working.

The most satisfactory mechanical device is that due to Smee.

The Smee Cell (1840).—One of the many forms in which this cell is made up is illustrated in Fig. 7. The positive element consists of two rect-

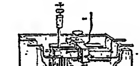


Fig. 7.—The Smee Cell.

angular plates of thoroughly amalgamated zinc; these plates are marked Zn and Zn in the figure, and one of them is partially cut away in order to show the position of the negative element; this element Ag lies between and parallel to the positive plates, and like them is rectangular in form. The negative element is the characteristic feature of this cell; it consists of a platinum plate, on the surface of which platinum—in the form of a fine black powder—has been electrically deposited. The surface of such a plate is quite rough, being covered by an innumerable number of small projections and recesses.

When the cell is in action the hydrogen is evolved in the usual manner on the surface of the platinised plate, but it does not spread in a uniform layer over its surface; it accumulates in bubbles on the small projections, and when these bubbles grow sufficiently large, they break away from the plate, and rise through the liquid. A portion of the plate is by this means kept free from hydrogen, and polarisation is thus partially prevented.

In the cell illustrated the aliment consists of dilute sulphuric acid in the proportion of one of acid to seven of water, and it will be noticed that there is an unusually large quantity of the liquid present. The object of having such a large quantity present is to maintain its strength fairly constant round the plates, by allowing plenty of room for the heavy sulphate of zinc to settle at the bottom of the vessel. The expensive platinum plate can be replaced by a silver one upon which platinum has been electrically deposited, but a still cheaper substitute can be obtained as follows.—Take a copper plate and deposit electrically on its surface a granular layer of copper, then deposit over this a thin coating of silver, and finally deposit a coating of platinum. The plate thus obtained will work quite as well as one consisting entirely of platinum, and has the merit of being inexpensive.

Class III.

CELLS IN WHICH POLARISATION IS PREVENTED BY PURELY CHEMICAL MEANS.

The accumulation of hydrogen on the negative element cannot be entirely prevented by any mechanical device which has yet been suggested, but by the aid of chemicals it can be easily and completely accomplished. All that is necessary to bring about the desired object is to surround the negative element with some substance which is rich in oxygen, and which parts with it comparatively easily. Nitric acid, manganese dioxide, bichromate and permanganate of potash, are the substances most employed as oxidising agents; these substances unite with the hydrogen as it is given off, and thereby prevent its deposition on the negative element. These oxidising substances would attack and burn up the zinc in a very short time if the two were allowed to come into contact, and some precaution must therefore be taken to keep them apart. Where the oxidising agent is a liquid, it is usually placed with the negative element in a semi-porous pot, which is immersed in the acid that surrounds the zinc: the positive element is thus immersed in the aliment whilst the negative one is immersed in the oxidising agent, and both liquids are kept from mixing by means of the porous pot. The negative element must consist of some substance having a very low heat value, otherwise it would be attacked and burnt up by the liquid in which it is immersed; for this reason platinum and carbon, which both possess low heat values, are the substances which are most in demand.

The Grove Cell (1838).—Though this cell is old, it can still compare favourably with most of the modern types: of the many forms in which it is made up that illustrated in Fig. 8 is about the most convenient. The outer vessel—which is partially cut away in the figure—consists either of porcelain or of ebonite, with the dimensions 5" × 3" × 2". The positive element (Z Z) consists of amalgamated zinc bent into the form of a U, and immersed in an aliment consisting of ten parts of water to one of sulphuric acid—by volume. In the bend of the zinc is placed the porous pot—made of unglazed earthenware—which contains strong nitric acid as the oxidising agent The negative element P consists of a plate of platinum of the dimensions $5\frac{1}{2}" \times 2\frac{1}{4}" \times \cdot 002"$, and is immersed in the nitric acid as shown.

Polarisation is entirely prevented in this cell: it has an E.M.F. as high as 1·95 volts, and a resistance as low as ·2 of an ohm. When the nitric acid is not strong the E.M.F. falls, and the resistance rises. If the cell is quite right at starting work, the above figures will be about true, but the sulphuric acid gradually becomes converted into sulphate of zinc, at the same time that the nitric acid becomes more and more dilute, owing to the formation of water in it by the union of the free hydrogen with the oxygen in the acid; the resistance under these circumstances may rise as high as 1 or 1 5 ohms, whilst the E.M.F. drops to about 1·7 volts. This cell is undoubtedly a good one in situations where it can be used, but it gives off dark red fumes of nitrogen peroxide which are obnoxious and unhealthy, and which prohibit its use in any kind of confined places.

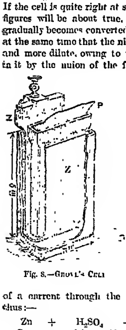


Fig. 8.—Grove's Cell

The reaction which occurs on the passage of a current through the cell may be expressed thus:—

$$\underset{\text{Zinc.}}{Zn} + \underset{\text{Sulphuric acid.}}{H_2SO_4} + \underset{\text{Nitric acid.}}{2(HNO_3)} + \underset{\text{Platinum.}}{Pt}$$

$$= \underset{\text{Sulphate of zinc.}}{Zn\,SO_4} + \underset{\text{Water.}}{2(H_2O)} + \underset{\text{Peroxide of nitrogen.}}{N_2O_4} + \underset{\text{Platinum.}}{Pt,}$$

from which it is seen that there is no free hydrogen evolved by the passage of a current, and that polarisation cannot therefore take place.

This cell is suitable for sending a strong current for a moderate length of time, and is not adapted to intermittent work extending over a lengthened period. The E.M.F. of this cell increases slightly as the temperature is raised.

The Bunsen Cell.—In the Grove cell the platinum plate is an extremely expensive item in the initial

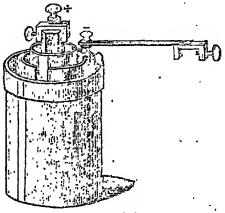


Fig. 9.—Bunsen's Cell.

cost of the cell, coming as it does to some fifteen shillings. Theoretically, the platinum ought to last for an infinitely long time, as it plays no active part in the working of the cell, but in practice it is found that the constant setting-up and taking-down of the cells eventually results in the platinum getting crumpled and broken.

In the Bunsen cell—one form of which is illustrated in Fig. 9—the materials used are exactly the same as in the Grove, with the exception of the negative element, which consists of a block of hard retort carbon instead of platinum. In the figure this carbon is marked G, and it carries a brass terminal on its top for making connection; it is square in section, and is contained in a circular porous pot, which also contains the oxidising agent—strong nitric acid. The zinc Zn forms nearly a complete cylinder, encircling the porous pot, and immersed in an aliment of dilute sulphuric acid, as in the Grove cell. The whole is contained in a circular pot of glazed earthenware. The terminal bar attached to the zinc shows the manner in which the zinc of one cell can be connected to the carbon of an adjacent one when it is desired to connect up a number of these cells in series. In using Bunsen cells it is advisable to clean those portions of the binding-screws that come into contact with the carbon and zinc whenever the cells are being made up.

The E.M.F. of this cell is slightly lower, and its resistance somewhat higher than that of the Grove, but in all other respects the two are similar; the Bunsen, however, uses more acid, and is not nearly so compact in form as the Grove. The chemical reactions in the two are identical.

Fig. 10.—The Bottle Bichromate.

BICHROMATE CELLS.

The Bottle Type.—Fig. 10 illustrates what is usually known as the bottle form of the Bichromate cell. The negative element is composed of two carbon plates K K, which are fixed parallel to each other, and connected to one of the brass terminals that are fixed in the ebonite top of the flask. The positive element consists of the zinc plate Z, which is situated between the two carbons and parallel to them: the upper portion of this zinc plate is attached to a brass rod *a*, which slides tightly through a collar in the ebonite top, and by means of which the plate can be raised out of the liquid, or immersed in it as desired.

The same liquid acts both as ailment and depolarising agent, and consists of a solution of bichromate of potash, sulphuric acid, and water, in the following proportions:—

Water	12	by weight.
Bichromate of potash	1	
Sulphuric acid	2	

or, by volume,

Water	11 pints.
Bichromate of potash	1¼ lb.
Sulphuric acid	1 pint.

The bichromate of potash crystals should first be ground to powder, and then slowly added to the sulphuric acid, which should be kept well stirred the whole time. Cold water to the required amount should now be poured into the mixture, which will become warm, but which may be kept at a moderately low temperature by adding the water sufficiently slowly. The mixture is not fit for use till it has become quite cold.

The E.M.F. of this cell is about 2 volts, and its resistance is extremely low owing to the proximity of the plates; it gives off no noxious fumes like the Grove and Bunsen, and it can send a very strong current, but only for a short time; if, however, it be allowed to rest for a short time it quickly recovers itself. The great objection to the use of this cell lies in the fact that the zinc cannot be allowed to remain in the liquid while the cell is not working. Owing to the strongly oxidising tendency of the solution, the zinc would be violently attacked and quickly burnt away if it were allowed to rest in the liquid. For this reason the zinc must be raised out of the liquid the instant the cell ceases to work.

The reaction which occurs in the cell may be expressed thus:—

$$\underset{\text{Zinc.}}{3\,Zn} + \underset{\text{Sulphuric acid.}}{6H_2SO_4} + \underset{\text{Chromic acid.}}{2CrO_3} + \underset{\text{Carbon.}}{C}$$
$$= \underset{\text{Sulphate of zinc.}}{3\,Zn\,SO_4} + \underset{\text{Water.}}{6H_2O} + \underset{\text{Chromium sulphate.}}{Cr_2 3(SO_4)} + \underset{\text{Carbon.}}{C.}$$

The Trouvè Bichromate.—A battery consisting of six of these cells is shown in Fig. 11. Each cell contains two plates of carbon and one of zinc, immersed in a bichromate solution, which is contained in an ebonite pot. The device is also shown by which the plates can be raised out of the liquid when the cells are not at work. The solution is composed as follows:—

Water	120	by weight.
Bichromate of potash	18	
Sulphuric acid	27	

This cell met with marked success at the time when it was brought out (1883) for running glow lamps of small voltage, and for various kinds of work requiring strong continuous currents.

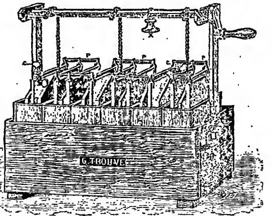


Fig. 11.—The Trouvè Bichromate.

Fuller's Bichromate.—This cell is made up in a

number of different forms, one of which is shown in Fig. 12. The outer vessel contains the negative element (carbon) marked *a*, and the bichromate solution; this solution may be made as previously described, or from the following receipt given by Poggendorff:—

Water	1000	by weight.
Bichromate of potash	100	
Sulphuric acid	50	

The positive element consists of the zinc block z, which is thoroughly amalgamated, and which is immersed in very dilute sulphuric acid contained in the porous pot; a little mercury is also added to this pot in order to maintain the zinc well amalgamated.

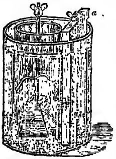


Fig. 12.—Fuller's Bichromate.

This form of bichromate has the same E.M.F. as the other varieties, but has a much higher resistance. On the other hand it possesses the very distinct advantage that both elements can remain in their respective places in the cell when no current is being sent; this is the case, since the chromic acid is not in contact with the zinc.

The bichromate solution is of a rich orange colour, which changes to blue as the bichromate becomes exhausted. If, however, it is exhausted while still maintaining its orange colour, the addition of some strong sulphuric acid will quickly restore it.

GREEK.—I.

INTRODUCTION.

The *Greek Language* is the language of the *Hellenes*, or *ancient Greeks*. The ancient Greeks were early divided into three great races, each of which originally used a different dialect both in poetry and in prose. The *Ionic* dialect was spoken by the Ionic race in Asia Minor and in Attica, and latterly passed into the Attic dialect. The *Æolic* dialect was spoken by the Æolians in parts of Asia Minor, Bœotia, and Thessaly. The *Doric* dialect was spoken by the Dorians, chiefly in Northern Greece, in the Peloponnesus, as well as in Crete, Sicily, and Magna Græcia by the Dorian colonists. The Greek language and the Latin language form what are termed *the classical languages*. By the term *classical languages* we designate those languages in which are written the works which, in modern times, learned men have agreed to regard as *classical*; that is, works that stand in the *first* or *highest class* of the productions of the human mind. The Greek language is a branch of the great family of languages which, under the name of *Indo-Germanic*, is now known to have extended from Scandinavia to the Indus, embracing, as its two principal components, the *Sanscrit*, or ancient language of the Brahmins, on the East; and on the West, the *Teutonic*, including the *German*, the *Dutch*, and the *English*. It is thus seen that the Greek is allied to our own tongue. It is allied to the English in regard to structure. What is more obvious to the beginner is, that the Greek is allied to the English in words; thus, for example, our word *one* is the Greek ἕν (hen); *two* is the Greek δύο (du'-o); *three* is the Greek τρεῖς (triee). The English pronoun *I* is only an abbreviated form of the Greek ἐγώ (eg'-o), which signifies *I*. Our verb *know* is the Greek γνω (no) in the verb γιγνώσκω, *to know*; the sound being identical, and the variation existing only in the letters. Many instances of identity between words in English and Greek will appear in the course of these instructions. At present it is sufficient to state the general fact.

With the Latin the Greek is connected more intimately than with the English. So much in common have the two, both in words and in the inflection of words, that a knowledge of the one affords great assistance in the study of the other. In general, indeed, a thorough acquaintance with any one language conduces to the attainment of others. But here the relationship is so close that the aid is special. That aid may extend its operation to the whole class of languages known as the *Indo-Germanic*; so that those who become familiar with Greek thereby acquire facilities for studying not only Latin, but also Sanscrit, German, and English.

Greek is a very old language. Homer's works go back to nearly a thousand years before the birth of Christ, and at the time when they were produced the Greek language was already a settled tongue; and it must have existed and have been spoken by persons of no small culture for centuries. Under the name of the *Romaic*, the Greek language—a good deal modified—is still spoken and written, being the vernacular or native tongue of the modern Greeks, who are the descendants of the ancient Greeks, and dwell on the same soil.

The Greek language, as developed and perfected in its Attic form, is the richest and most perfect and philosophical language in the world. It owes

its superiority above all to the variety of its inflections, its power of forming compounds, its adaptability, and its harmony. It was said of old that if the gods were to descend to earth, they would speak the language of Plato, the famous Greek philosopher. The spirit of the saying is borne out by fact. The Greek is a wonderful and beautiful instrument of human thought.

But the study of Greek is worthy of attention, if only as a means of self-discipline. Self-discipline is the true end of education. Nothing better can be given to any mortal than a well-cultivated mind. The man whose faculties are in their highest state of development, and their greatest degree of activity and productiveness, stands at the summit of humanity, and now enjoys what he has reached, namely, the perfection of his earthly being.

The study of Greek is pre-eminently fitted to educate our mental powers. All linguistical studies are useful for that purpose. Looking at their effects in their several bearings, we may declare that the study of languages is of all studies the most useful. But the Greek language has the special recommendation of being more subject to rule than other languages. It deals too with wider reaches of intellect and subtler distinctions of thought than most other tongues can comprise or define.

But there is a recommendation of the study of Greek which throws all others into the shade, for it was in Greek that the Scriptures of the New Testament were written. And we need not point out how much more easily and thoroughly we are able to enter into the spirit, and feel at once the beauty and the power of the thoughts and lives of Christ and his Apostles, when we can read the records of them in the very words in which they were first written down.

In connection with the study of theology, we may observe that the word "theology", and almost all our *ecclesiastical* and *theological* terms, are derived from the Greek. The English words *bishop*, *baptism*, *atheist*, *liturgy*, *diocese*, *cathedral*, with a host of others, are all drawn from the Greek.

Greek, however, is not without a claim which, though more humble, may with some persons be more valid. That claim it lays before all who study or propose to study the sciences. Though some of the sciences did not exist, even in rudiments, during the classical days of Aristotle, and though other sciences have been carried far beyond the boundaries where they were left by Euclid and by Galen, yet to a great extent the language of science is Greek; for such is the readiness with which Greek lends itself to combination, that the moment a new science is elaborated—nay, the moment a new fact is ascertained, or a new elementary substance is discovered—that moment some form or forms of words are produced from Greek elements, which exactly set forth the novelty. Hence these scientific names are so many definitions, and being definitions they describe the objects which they are used to designate; at all events to such students as are familiar with Greek. Take *photography* as an instance. This word is made up of two Greek words, φῶς (phose), *light*, and γραφή (graph'-phee), *a painting*, and so means *light-painting*; that is, a painting made by the *solar rays*. The student will find many illustrations of the fact that, in English, Greek is very largely the language of science.

As the language of science, Greek is of special service to all men of science; in particular is it of great service to medical men. A vast number of the words with which they have to do in their studies are of Greek origin. Those words, to persons ignorant of the Greek tongue, are so many unknown terms, the meaning of which has to be learnt as a mere matter of routine; but to the proficient in Greek *they define themselves*, and so describe the objects which they represent. Take, as an example, the word *bronchitis*. Now we may never have studied medicine, yet, from our knowledge of Greek, we know that *bronchitis* is a disease whose seat is in the βρογχία (bronk'-i-a), that is, *the extremity of the wind-pipe*.

In proceeding to the study of Greek, you are stopped at the very threshold, for the characters of the letters are not the same as those of your native tongue. The diversity, however, is in appearance more than in reality. In fact, the English alphabet was derived from the Latin, and the Latin alphabet was derived from the Greek. It may be added, that the Greek letters can be traced back to the Phœnician. Thus the English and the Phœnician alphabets are related to each other. In the descent of the letters, however, from age to age, and in their passage from one people to another, they underwent considerable changes; so that, at least in some instances, it is only by supplying the intermediate forms that we can discover the identity. Yet scarcely is the difference in any case much greater than exists between what we call *Old English* or *Black Letter*, and the letters now employed in ordinary printing; or those, again, which are used in writing.

We have made these remarks in order not only to state an important fact, but to induce you to compare the forms of the Greek letters with the corresponding English forms. By so doing you will be much aided in becoming familiar with the Greek letters.

THE GREEK ALPHABET.

Characters. Capitals.	Small Letters.	English Equivalents in Sound.	Name in English.	Name in Greek.
Α	α	a	Alpha	Ἄλφα.
Β	β	b	Bēta	Βητα.
Γ	γ	g (hard)*	Gamma	Γαμμα.
Δ	δ	d	Delta	Δελτα.
Ε	ε	e (short)	Epsīlon	Ἐψιλον.
Ζ	ζ	z	Zēta	Ζητα.
Η	η	e (long)	Ēta	Ἡτα.
Θ	θ	th	Thēta	Θητα.
Ι	ι	i	Iōta	Ἰωτα.
Κ	κ	k	Kappa	Καππα.
Λ	λ	l	Lambda	Λαμβδα.
Μ	μ	m	Mu	Μυ.
Ν	ν	n	Nu	Νυ.
Ξ	ξ	x	Xi	Ξι.
Ο	ο	o (short)	Omīcron	Ὀμικρον.
Π	π	p	Pi	Πι.
Ρ	ρ	r	Rho	Ῥω.
Σ	σ ς	s	Sīgma	Σιγμα.
Τ	τ	t	Tau	Ταυ.
Υ	υ	u	Upsīlon	Ὑψιλον.
Φ	φ	ph	Phi	Φι.
Χ	χ	ch	Chi (like ki)	Χι.
Ψ	ψ	ps	Psi	Ψι.
Ω	ω	o (long)	Omĕga	Ὠμεγα.

Of these five columns the *first* gives the Greek letters in *capitals;* the *second* gives the same letters in *small forms;* the *third* gives the corresponding *English letters*, that is, the forms in English which have sounds similar to the several Greek letters; the *fourth* gives the *Greek name* of the letters; and the *fifth* gives the *same name* in Greek characters. The names, as they appear in the last column, are the designations which you are to assign to the Greek letters; that is, you are to call α not *a*, but *alpha;* β not *b*, but *beta*, and so on.

Before you can advance another step, you must make yourself thoroughly familiar with these characters—with their names and their values or sounds. In general, you may follow your ordinary English methods of pronunciation; one or two exceptions will be pointed out immediately. Your present business is to acquire a facility of transferring the Greek characters into corresponding English characters, and to read the former in the sounds of the latter. In the requisite application we advise you to employ a slate and pencil. Write the alphabet several times merely in Greek. Then compare together such Greek characters as resemble each other, and carefully mark wherein they differ. Having become familiar with the mere forms, associate with each its own name. Then study the sounds—that is, pronounce each Greek letter in the corresponding English sound. These processes you must go over again and again, until you are perfectly master of the whole, and can from memory write down the alphabet, with all its forms and parts, as here given. We advise you to take great pains in this matter, and not to pass on until you have thoroughly accomplished this task. Your attention to this recommendation will save you a world of trouble.

* Before another γ, or κ, χ, ξ, gamma has the sound of ν.

In the commencement, you will do well to confine yourself to the *small characters;* having acquired them, you will readily make yourself familiar with the *capitals*.

In the small characters, you will at once discover similarities between the Greek and the English forms. The Greek α and the English *a* are obviously the same. The English *o* and the short *o* in Greek are very nearly alike. The two *b's* differ little. The two *i's* are identical; so are the two *o's* (*o* short); and the Greek *o* long (ω) is nothing but two short *o's* (*oo*) put together.

You will notice in the Greek two forms of the small letter *s*. These two forms are σ and ς. Of these, the first occurs at the beginning and in the body of a word; the second stands at the end of a word. This form of the *sigma*, namely, ς, may also be used in the middle of compound words, when the first of the words of which the compound is formed ends in *s*: for example:—

Ordinary Sigma.	Sigma at the end.	Sigma in Compounds
δουλώσω	δρασμός	δυςγενής
σεισμός		προςφέρω.

Gamma, γ, has the sound of *n* before γ, κ, χ, ξ: thus, Γάγγης is pronounced gang'-ees; συγκοπή is pronounced sune'-ko-pe; Κέγχριος, ken'-kri-os; and λάρυγξ, lăr-ūnx.

Chi, χ, has a guttural sound, and so differs from *kappa*, κ. The letter χ is never pronounced like our *ch* in *church*, but always in a way resembling our *k* in *kite*, *kitchen*, *kick*.

Over vowels, *e* in *bēta*, *i* in *epsīlon*, etc., the mark ¯ will be observed. It is used to denote a *long* vowel. The force of it you may give by throwing the stress of the voice on the vowel or syllable over which it is placed. Thus *omīcron* is to be pronounced *o-mī'-kron*. The opposite of ¯ is ˘, as in *omĕga;* the mark ˘ denotes a *short* syllable; accordingly, *omĕga* is pronounced thus, *o'-meg-a*, with the stress on the *o*. A vowel of doubtful length is marked thus ¯˘, as ā̆. When two vowels come together, the former is generally short, as Ἴλῐον, *i'-li-on*. Diphthongs, however, are long; that is, on them you must throw the stress, as αὐξάνω, *au'x-a-no*.

Syllables are short or long, as they contain a short or long vowel. Syllables containing a diphthong are long.

You may ascertain whether you have mastered the letters by practising yourself in the following

Exercise for Pronunciation.

N.B.—Every vowel in Greek, whether at the end of a word or not, is pronounced as a separate syllable

Κα, κε, κη, κι, κο, κυ, κω. Γε, γο, γη, γω, γα, γι. Χη, χω. Τα, τε, το. Δε, δη. Θη, θι, θεα, θητα. Πι, πω, πας. Βαλλω. Φι, φερω, Σα, σον, σιγη. Φυγη, φυγω. Ματερ, μελος. Ψι. Γασηα. Ζητα, ζητεω, ζητησις; Ξανθος; Νυκτες; Χθων.

᾿Αλεξανδρος, Αὐλις. ᾿Ωλην, ᾿Ωκεανος. ᾿Ωρωπος. Ψαμμις, Ψαμμετιχος. Βιας. Γη. Γλαυκος, Γοργη. Χαριτες, Χαριλαος. Φωκευς, Φωκΐων, Φρυγες. Ὑδρα, Ὑπᾶνις, Ὑλλος. Δολοψ, Διονῦσος, Διοσκουροι. ᾿Ερις. Ζακυνθος, Ζευξις. ᾿Ηλεκτρα. ᾿Ηχω, ᾿Ηως. Κιμβροι. Λυδια, Λυσιας, Λοκρις, Λακεδαιμων. Νικη. Μινως. ᾿Ολυμπος. Πλαταια, Πιττᾰκος. Σαλαμις, Σακας, Σκυθια. Τιτᾶνες. Ῥοδος, Ῥωμη, Ῥηγιον.

You will have noticed already these three marks, namely, ‘ above the letter (or to the left of it in capitals), as in ἱνα; ’ in the same position, as in ἐπι; and ι under the letter, as in ᾠδη. The first is called the *spiritus asper*, or *rough breathing*, being equivalent to our aspirated *h*; pronounce, then, as with an *h* syllables before which this aspirate is placed, as Ἁδης, *Hades*. The second is called the *spiritus lenis*, or *smooth breathing*, and simply marks the absence of the aspirate. The third mark is called *iota subscript* (*i underwritten*), so termed because the letter *i*, instead of appearing at the end, as in λογωι, is written or placed under the ω as in λογῳ: this mark is commonly disregarded in pronunciation.

Besides these marks, you will notice others on nearly every word, which are called "accents". We have omitted them in the last paragraph in order not to distract your attention from the letters; but we must now explain their use.

Accents.

These signs are supposed to have been invented by a celebrated grammarian at Alexandria about two hundred years before the Christian era, in order to assist foreigners in learning Greek by marking the *pitch of the voice* at which the different syllables of words were pronounced. In English we pronounce almost entirely by *stress* laid upon syllables, having lost for the most part even quantity, as understood by Greeks and Latins. Accordingly in our pronunciation of Greek we are accustomed to disregard "accent" altogether, and to observe only the quantity of vowels. In modern Greek, on the other hand, quantity is entirely disregarded, and pronunciation is regulated by stress on the accented syllable. But the ancient Greeks seem to have observed both quantity and "accent" of syllables in their pronunciation, and this accent seems to have been some kind of modulation of the voice—a sharper tone or higher pitch—which they were accustomed, as a result of their musical training, to easily employ and detect.

This accent was of three kinds—the acute (´), or high pitch; the grave (`), or low pitch; and the circumflex (˜), intermediate between the acute and grave. The acute is only found on final syllables before a pause (a period, colon, or comma); in the middle of a sentence it becomes the grave.

A word	with the	acute	on the	last syllable	is called	*oxytone.*
,,	,,	,,	,,	penultima	,,	*paroxytone*
,,	,,	,,	,,	antepenultima	,,	*proparoxytone.*
,,	,,	circumflex	,,	last syllable	,,	*perispomenon*
,,	,,	,,	,,	penultima	,,	*properispomenon*

A few general rules can be drawn up as to accentuation:—

I. Every word has one accent, and only one; and it cannot be placed further back from the end than on the antepenultima. The circumflex cannot stand further back than on the penultima.

II. If the last syllable be long, the accent cannot be further back than the penultima, and no such word can be properispomenon.

III. If the last syllable be short, and the penultima long, the accent—if on the penultima—must be circumflex.

IV. For purposes of accentuation, quantity by nature only (not by position) is regarded; and final syllables in -αι and -οι are considered short (except 3rd pers. sing. of tenses in the optative mood, and the adverb οἴκοι, at home).

Besides these general rules (to which there are, however, some exceptions), there are special rules for the accentuation of special classes of words. We may confine our attention at present to the

Accents of Nouns.

The accent on the nominative can only be learnt by observation.* The accent on the oblique cases is generally on the same syllable as in the nominative, or on the syllable nearest to it (if one of the general rules mentioned above interferes). But

(1) Genitives plural, 1st declension, and all

* Such general rules as can be drawn up will be found in a little book, "Laws of the Greek Accents", by Dr Griffiths, published by Parker and Co. (price 6d.), to which the student is referred for further particulars of the laws of accentuation.

genitives and datives, 1st and 2nd declensions, of oxytone words, are *perispomena*.

(2) Genitives and datives of monosyllables of the 3rd declension are accented on the last syllable.

Pronouns, adjectives, and participles are accented as nouns.

The student is strongly recommended to master these rules first, and to notice carefully in the exercises we shall give, and so learn by experience, the accent on the nominative. When we come to the verbs we shall give the rules for their accentuation. We need only here mention that in general they throw back the accent as far as possible. (This is termed *recessive* accent.)

THE ATTIC DIALECT.

It must furthermore be observed that the Greek language comprises several dialects, differing from each other in various particulars, but especially in respect of the vowel-sounds. (In a similar manner there are still a good many different dialects of English spoken in England, and the vowel-sounds are among their most characteristic differences.) The chief dialects were the Attic, the Ionic, the Doric, and the Æolic. Of these, the Attic is really a later development of the Ionic (in which the Homeric poems are written), but must be regarded as distinct from it. It was the language of the Athenians, and in it most of the great masterpieces of Greek literature were written. The tragic poets Æschylus, Sophocles, and Euripides; the historians Thucydides and Xenophon; the comic poet Aristophanes; the philosopher Plato; the great orators, among whom Demosthenes stands pre-eminent: all used the Attic dialect. And the later Greek followed the same forms in the main.

In these lessons we shall confine ourselves to the Attic dialect. One of its chief features is the dislike of open vowel sounds: that is, vowels pronounced separately side by side as syllables. Accordingly the two vowels were run together as much as possible to form a single syllable (*i.e.*, either a long vowel or a diphthong). This is called *contraction* (Lat. con-traho, *draw together*).

CONTRACTION.

The following are the chief principles which regulate the contraction in Attic Greek of open vowels arising from inflection:—

1. If possible, they form a diphthong—*e.g.*, τείχε-ι = τείχει.

2. If one of them is ο or ω the ο sound prevails, and they contract to ω. But εο and οο = ου.

3. When α and ε (or η) occur together, the first sound prevails, and they contract to ᾱ or η accordingly.

4. εε = ει.

5. A vowel before a diphthong with the same initial is absorbed—*e.g.*, ἁπλό-οις = ἁπλοῖς. ε is absorbed before οι (and, in nouns and adjectives before αι).

A vowel before a diphthong with a different initial is contracted according to rule with the first vowel, and the second disappears, unless it is ι (when it is written under the contract vowel)—*e.g.*, τιμά-ει = τιμᾷ.

These rules embody the main principles of contraction, but there are some notable exceptions demanding equal attention, which we now proceed to give, with reference to the above rules.

Exceptions to—

2. In contract adjectives in -εος, ο is lost before α and η, αι and ῃ.

In verbs in -οω, οει and οῃ = οι, οειν = ουν.

3. In the 1st and 2nd declensions, dual and plural, and in all cases after a vowel or ρ, εα = α—*e.g.*, ὀστέα, ὀστᾶ; ὑγιέα, ὑγιᾶ.

4. In the dual of the 3rd declension εε = η.

5. In verbs in -αω, infin. -άειν = ᾶν (the iota being lost).

Some verbs in -άω contract η for α (*e.g.*, διψάω, ζάω, κνάω, πεινάω, σμάω, χράω, ψάω).

Disyllabic verbs in -έω admit contraction only when two epsilons come together (εε and εει).

The student must master these rules as soon as possible, and carefully notice the illustrations of them in the following lessons, and question himself about them, frequently referring to this page.

VOWELS, CONSONANTS, PUNCTUATION, ETC.

The Greek alphabet, consisting of four-and-twenty letters, is made up of seven vowels and seventeen consonants. The vowels are α, ε (η), ι, ο (ω), υ. According to their quantity, long or short, they may be divided thus:—

VOWELS.

Short.	*Long.*	*Doubtful.*
ε, ο.	η, ω.	ᾰ, ῐ, ῠ.

By "doubtful" is meant, that the vowels so termed are sometimes short and sometimes long: which they are, in any case, is learnt by usage, particularly by the usage of the poets.

By a union of the vowels we produce

THE DIPHTHONGS.

αι, αυ. ει, ευ. οι, ηυ. υι, ου.

Besides these there are the improper diphthongs, formed by α, η, or ω, and the iota *subscriptum*, or written under, as ᾳ, ῃ, ῳ.

Both the proper and the improper diphthongs are long, or, in other words, receive the stress of the voice in pronunciation.

When two vowels commonly pronounced as one sound (a diphthong) are pronounced separately, a diæresis (separation) is produced, which is denoted by two dots set over the second vowel: as, εϊ, οϊ, αϋ.

Sometimes a vowel at the end of a word or syllable, standing before another vowel which begins a word or syllable, is elided or struck out, when we produce what is termed elision (Latin e, *out of*, and lædo, *I dash*). Instead of the elided vowel, an apostrophe ' is put. Elision takes place in all the prepositions except περί and πρό. When prepositions are compounded with verbs that begin with a vowel, the apostrophe is not used; thus, ἀπ' οἴκου is the elided form of ἀπὸ οἴκου, and ἀπέφερον is the elided form of ἀπο-έφερον.

When, however, the two vowels thus coming the one before the other are melted or blended together, so as to form one long syllable or diphthong, what is grammatically called crasis (Greek, *a mixing*) takes place. Thus τὸ ἔπος by crasis or krasis becomes τοὖπος. By resolving the double vowel into its component parts—that is, by the inversion of crasis or by dissolution—you obtain the two words entire; so τοὖπος becomes τὸ ἔπος; also τἀγαθά becomes τὰ ἀγαθά.

The Greeks paid great attention to euphony, or pleasing sound. Consequently they studied to prevent two vowels from coming into immediate succession, so as to cause an hiatus (Latin, *a gaping*) or stoppage of the flow of the sound—such a stoppage as takes place when we say *a* hiatus. To avoid this unpleasant suspension of the breath, we, in English, convert *a* into *an* before a word beginning with a vowel. In the same way, and for the same purpose, the Greeks employed a ν at the end—

1. Of the dative plural in σι, and adverbs of place ending in -σι: as, πᾶσιν ἔλεξα; ἡ Πλαταιᾶσιν ἡγεμονία.

2. Of the third person singular and plural ending in -σι: as τύπτουσιν ἐμέ; τίθησιν ἐν τῇ τραπέζῃ: also with ἐστί: as, ἔστιν ἐμοί.

3. Of the third person singular in -ε. as, ἔτυπτεν ἐμέ.

4. Of the numerals: as, εἴκοσιν ἄνδρες; but not always; therefore we find also εἴκοσι ἄνδρες.

Regard to euphony also led the Greeks to drop the σ in the adverb οὕτως before a word beginning with a consonant: thus, οὕτως ἐποίησεν; but οὕτω ποιῶ.

Thus the preposition ἐκ, as in ἐκ τῆς εἰρήνης, becomes ἐξ before a vowel, as ἐξ εἰρήνης.

The same practice obtains in the negative οὐκ (not, no), as οὐκ αἰσχρός, οὐ καλός; also, οὐχ ἡδύς. In the last example the aspirate in ἡδύς requires the aspirated form of κ, that is χ, immediately before it, for in Greek only letters of the same kind go together, that is, a soft sound with a soft sound, a hard with a hard, and an aspirated sound with an aspirated sound.

The points employed in punctuating Greek are few; by the original writers points were not used at all. The comma and the period are employed as in English. What with us is called the semicolon is used in Greek as a note of interrogation; and the colon is one dot placed at the top of the word, thus—

Colon · Εἰ ἔλεξας·
Period . πάντες ὡμολόγησαν.
Interrogation ; τίς ταῦτα ἐποίησεν;

BOTANY.—XV.

[*Continued from Vol. IV., p. 357.*]

Our space will not allow us to enter into much detail as to the various groups of flowering plants, so we must content ourselves with referring to the leading structural characters of the sub-classes, series, and cohorts, only mentioning the chief natural orders in each cohort, and very briefly touching upon the more interesting genera and species in these orders.

The *Polypetalæ*, though including exceptional genera or species which are either apetalous or gamopetalous, have typically both calyx and corolla, the latter made up of separate petals. Their flowers are usually also perfect. Of the three series which this sub-class contains, the *Thalamifloræ* have usually a calyx not only inferior, but also polysepalous, hypogynous petals and stamens, and a superior gynæceum; the *Disciforæ* have also usually hypogynous stamens which are definite in number and a superior gynæceum, but take their name from the usually conspicuous glandular hypogynous disk; and the *Calycifloræ* are usually gamosepalous, and have perigynous or epigynous corollas and stamens, the ovary in the latter case being necessarily inferior.

The first of the six cohorts included in the *Thalamifloræ* takes the name *Ranales* from the chief natural order it contains, the *Ranunculaceæ*. In this cohort the parts of the flower are commonly arranged in a spiral, the stamens, and sometimes the carpels, being indefinite in number, the carpels seldom united, and the seeds generally albuminous. We have already said a good deal about the *Ranunculaceæ* in our last lesson. Nearly all of them are herbs with alternate leaves and imbricate æstivation; but *Clematis* is exceptional in being a woody shrub with opposite compound leaves and valvate

sepals. In this genus, as in *Anemone* and *Caltha*, petals are absent, the sepals being petaloid. The petals in *Ranunculus* have a nectariferous scale at the base; those of *Aquilegia*, the columbine, are spurred; and those of *Helleborus*, including the Christmas rose (*H. niger*), are small tubular nectaries. The flowers of the larkspurs (*Delphinium*) and of *Aconitum* are monosymmetric. The fruit is an etærio of achenes in *Clematis*, *Anemone*, and *Ranunculus*; a ring of follicles in *Helleborus*, *Delphinium*, *Aquilegia*, *Caltha*, and *Pæonia*. In *Anemone* there is an involucre of three leafy bracts, and the styles often persist as feathery "awns" to the ripe carpels, as they do also in *Clematis*, from which character our one British species, *C. Vitalba*, obtains its popular name of old man's beard. Most members of the order have a more or less acrid juice, and more than one poisonous principle abounds in the *Ranunculaceæ*, but of these *aconitine* is the most violent. It is a white substance, something like flour to look at, and so frightfully poisonous that the twentieth part of a grain, or even less, is a fatal dose. Of all the various species of *Aconitum*, *A. ferox* is the most dangerous. This plant grows in the Himalaya Mountains, and was on one occasion used by the Nepaulese as a means of ridding themselves of us, their invaders. A few leaves of this plant being thrown into a well, poisoned all the water to such an extent that men or beasts drinking of it were almost infallibly killed.

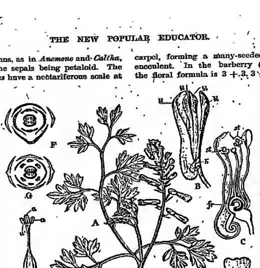


Fig. 60.—A, Fumitory (*Fumaria*). B, Side-view of Flower. L, sepal; bl, petal. C, Flower in Longitudinal Section: st, bundle of stamens; fr, ovary. D, Bundle of Stamens: a, centre two-chambered anther; a', lateral dimidiate anthers. E, Fruit. F, Diagram of Fumariaceous Flower. G, Diagram of *Cruciferæ*.

Besides the *Ranunculaceæ*, the cohort *Ranales* includes the *Magnoliaceæ*, *Berberideæ*, and *Nymphæaceæ*. The *Magnoliaceæ* include, besides the various American, Japanese, and Himalayan trees of the genus *Magnolia*, the American tulip-tree, *Liriodendron tulipifera*, with remarkably truncated leaves.

The *Berberideæ* have their floral organs in whorls of two or three, but their gynæceum consists of one carpel, forming a many-seeded fruit, sometimes succulent. In the barberry (*Berberis vulgaris*) the floral formula is 3 + 3, 3 + 3. 3 + 3. 1, and the leaves or their stipules are more or less reduced to spines (Fig. 71). The members of this genus are attacked by a parasitic fungus or "rust," later stages in the life of which are passed upon wheat or other grasses, forming a most destructive pest.

The *Nymphæaceæ* are aquatic plants with rhizomes imbedded in the mud; leaves usually round and floating, with large air-spaces in their petioles, as also in the peduncles; the floral organs indefinite and arranged spirally, the sepals passing into petals and the petals into stamens. In most of the genera as, for instance, in *Castalia* and *Nymphæa*, common in English rivers, the carpels are united into a multilocular superior or inferior capsule with superficial placentation and both perisperm and metasperm in the numerous seeds. *Nelumbium*, the "lotus" of the Egyptians, has peltate leaves above the water and its carpels one-seeded and imbedded separately in hollows on the upper surface of the large obconic or hemispherical receptacle. *Victoria regia*, a tropical American species, is remarkable for its leaves, three to four feet across.

The *Parietales* take their name from the usual character of their placentation. They are mostly cyclic, polysepalous, and syncarpous. The cohort includes eleven orders, among which are the *Sarraceniaceæ*, or side-saddle plants, of North America, with pitcher-like radical leaves, *Papaveraceæ*, *Fumariaceæ*, *Cruciferæ*, *Capparideæ*, *Resedaceæ*, and *Violarieæ*.

The *Papaveraceæ*, or poppy tribe, is characterised by milky latex, dimerous perianth-whorls, sepals generally caducous, and stamens in numerous alternating whorls. The floral formula is 2. 2 + 2. ∞. (2) or (∞). In *Papaver*, the poppies, the petals are crumpled in æstivation, and the fruit is a porous

one-chambered capsule with numerous radiating partial partitions, superficial placentation, and a radiate stigma. *Chelidonium* has an orange latex and only two carpels, which form a one-chambered

Fig. 70.—Ladies-Smock (*Cardamine pratensis*). A, Inflorescence and Cauline Leaves. B, Radical Leaves and Root.

fruit externally resembling a siliqua. Opium is the dried latex of the unripe capsules of *Papaver somniferum*.

The *Fumariaceæ*, a small order of glabrous herbs with watery juice and monosymmetric flowers, have a remarkable andrœcium of four stamens, generally diadelphous with one whole and two half stamens in each group (Fig. 69). *Dielytra spectabilis*, now a common garden plant, has a raceme of pendulous flowers with two minute sepals, pink spurred outer petals and white inner ones enclosing the anthers.

The *Cruciferæ* are a large and valuable order of herbs agreeing closely in their leading characters. Their leaves are alternate and generally simple and exstipulate (Fig. 72); their inflorescence is an ebracteate raceme, often corymbose (Fig. 70); the floral formula is $2 + 2.\ \times 4.\ 2 + 2^{\times 2}.\ (2)$—that is, there are four sepals in two whorls, four petals, placed diagonally as if alternating with one whorl of four sepals, and tetradynamous stamens; the fruit is a siliqua and the seeds are exalbuminous. The four longer stamens probably represent two bifurcating ones, and it will be remembered that the characteristic of the siliqua is to be at once two-chambered and parietal in placentation, having a replum, to the margins of which the seeds remain attached when the valves fall off. The siliqua varies much in shape, and is generally compressed either parallel with (*latisept*) or at right angles to (*angustisept*) the replum. In a few cases, as in candytuft (*Iberis*), the outer flowers in the corymb have their outer petals larger, and are, therefore, monosymmetric; and in *Raphanus* and others the siliqua is lomentaceous. The characters of the fruit and the folding of the cotyledons serve to divide the order into tribes. Many members of the order are valued for their flowers, the petals being most commonly yellow, white, or less frequently red. The *Cruciferæ* are dispersed all over the surface of the globe, the greater number, however, inhabiting the northern temperate zone, more especially of the Old World, whilst between the tropics they are rare, and when they exist, are found on mountain elevations, and beyond the Tropic of Capricorn they become less frequent, even more so than beyond the Tropic of Cancer. There are no poisonous plants in the order, most of them being antiscorbutic, containing a good deal of sulphur and nitrogen, and a volatile stimulating oil. In decomposing they give off sulphuretted hydrogen. *Brassica* includes many

Fig. 71.—Barberry (*Berberis vulgaris*). B, Flower. C, Pistil and one Stamen showing operculate dehiscence. D, Fruits.

long-cultivated species and varieties: *B. oleracea*, the cabbage, with its varieties, *bullata*, the savoy; *botrytis*, with a fleshy abortive inflorescence, the cauliflower; *gemmifera*, the Brussels sprouts; and

caulorapa, with enlarged stem, the kohl-rabi; *B. Rapa*, with enlarged root, the Turnip; *B. Napus*, the rape; and *B. nigra* and *alba*, the mustards, with oily seeds. *Nasturtium officinale*, the watercress; *Cochlearia Armoracia*, horse-radish; *Crambe maritima*, sea-kale; *Raphanus*, the radish; and *Cheiranthus*, the wallflower, are other well-known members of the order.

The *Capparideæ*, a tropical and sub-tropical group, are remarkable for the elongation of their floral internodes and for containing one of the few cases, that of the caper (*Capparis spinosa*), in which flower-buds are eaten.

Resedaceæ, the mignonette family, which has two British representatives, has stipulate leaves, a bracteate raceme and flowers which are monosymmetric from the one-sided growth of the large disk between the laciniate petals and the indefinite stamens. There are from two to six carpels usually forming a one-chambered ovary, but separating at the top before the seeds ripen. *Reseda odorata* is the mignonette.

Violaceæ include plants of various sizes, with stipulate leaves and usually monosymmetric flowers. *Viola odorata*, the sweet violet, and other species, have two kinds of flowers. In spring the conspicuous sweet-scented flowers are produced on comparatively long peduncles. Though these contain honey, secreted by the tail-like appendages of two of the anthers, in their spur, and are marked by guiding lines, they are seldom visited by insects and form little or no seed. Later in summer flowers that do not open (*cleistogamous*) are produced on short stalks and with reduced corollas, and these form capsules full of seed.

In the cohort *Caryophyllales* the order *Caryophyllaceæ* is the only one of importance. It takes its name from the carnations (*Dianthus Caryophyllus*), the smell of which resembles that of the clove, a member of a widely different order, which was formerly known as *Caryophyllus* from its leaf resembling that of the hickory (*Carya*). The *Caryophyllaceæ* are herbs with their stems often swollen at the nodes; leaves opposite, decussate and simple; inflorescence cymose; flowers cyclic, polysymmetric and pentamerous; petals, either red or white, and often notched; gynæceum of two, three, or five carpels united into a one-chambered ovary with free central placentation and distinct styles; fruit a capsule; and embryo curved round a floury albumen. *Lychnis*, the campions, have a ligule at the junction of the claw and limb of their petals, and in *L. Flos-cuculi*, the ragged robin, the petals are *laciniate*, or torn into shreds. Though including the pinks (*Dianthus*) and other showy garden plants, and the chickweed (*Stellaria media*), with bi-lobed petals, and other widely dispersed weeds, no member of the order is of much known use to man.

The cohort *Guttiferales* takes its name from the tropical order *Guttiferæ* or *Clusiaceæ*, the gamboge tribe. Gamboge is a yellow purgative resin mixed with gum, used as a paint, and obtained mainly from *Garcinia Hanburii* of Siam. The genus *Calophyllum* contains several fine timbers. Another mainly tropical order in this cohort is the *Camelliaceæ* or *Ternstrœmiaceæ*, woody plants with thick leaves and showy flowers. Besides the ornamental *Camellia japonica*, a native, as its specific name indicates, of Japan, this order includes the invaluable allied shrub *Thea viridis*, the tea-shrub. This is apparently wild in Assam, *T. chinensis* being the long-cultivated Chinese form. Tea owes its stimulating properties to the presence of the alkaloid *theine*. The temperate and northern order *Hypericineæ*, the St. John's-worts, are mostly perennials, with opposite, decussate, exstipulate, simple leaves, generally dotted with pellucid oil-glands, a cymose inflorescence, polysymmetric pentamerous flowers, three or five much-branched (*polyadelphous*) stamens, and exalbuminous seeds. There are several British species of *Hypericum*.

There are three orders in the cohort *Malvales*, which agree in having cyclic, pentamerous, polysymmetric flowers with five or ten stamens indefinitely branched and often connate (*monadelphous*), five or more united carpels and albuminous seeds. They are the *Malvaceæ*, *Tiliaceæ*, and *Sterculiaceæ*. The *Malvaceæ*, or mallow tribe, include mallows, hollyhocks and, most important of all, cotton. They mostly contain a mucilaginous juice, for which reason they are used in making cough lozenges. The leaves are scattered, stipulate, simple, and palmately veined: there is generally an epicalyx; the calyx is valvate and the corolla contorted in æstivation; the five stamens are indefinitely branched, and monadelphous, and have often dimidiate anthers; the fruit is a regma usually having only one ovule in each chamber, and this becomes an albuminous seed. Cotton consists of the long unicellular hairs on the testa of the seeds of *Gossypium*, different species of which are apparently indigenous in India, tropical Africa, Barbadoes, and Peru. The seeds yield an oil and oil-cake. The baobab (*Adansonia digitata*) of tropical Africa is a large tree with a spongy, rapidly growing stem, sometimes reaching a circumference of 100 feet, now used as a paper material. The *Tiliaceæ* are mostly trees or shrubs, with an exceptionally tough and well-developed liber or bast; simple leaves, usually scattered and with deciduous stipules; polysymmetric pentamerous

flowers; with valvate deciduous sepals; stamens ten or more in number; carpels usually five, united, with a single style, and usually two ovules in each chamber, only one in each pair forming a seed. *Tilia*, the linden, a British genus, has oblique leaves; the peduncle adherent for some distance to the leafy bract; and lateral flowers developed on either side of the terminal one in the axils of the bracteoles. The wood is used in carving and the bast is known as Russian matting, being largely imported from Russia. *Corchorus capsularis* yields jute, the most valuable East Indian fibre, which is largely used for cordage, backing carpets, etc., as a substitute for hemp. The *Sterculiaceæ* are a tropical and sub-tropical family, which includes the cacao and the kola nut. *Theobroma Cacao* is a tropical American tree, now cultivated elsewhere, with large pod-like capsules containing numerous seeds of considerable size. These seeds contain much fixed oil or "cocoa-butter," a red colouring matter, and an alkaloid, theobromine, allied to theine. The cotyledons when dry and split apart are called cocoa-nibs, and from them, when ground into a paste, chocolate is prepared. The seeds of *Cola acuminata*, a native of west tropical Africa, known as Kola or Guru nuts, are valuable as a digestive and to allay hunger. They contain more theobromine and more starch than does the *Theobroma*, and more of the characteristic alkaloid of coffee, caffeine, in a free state than the best coffee.

The series *Disciflorœ* agree with the *Thalamiflorœ* for the most part in having their corolla and stamens hypogynous and their ovary superior, and the usually conspicuous disk from which they take their name may be a ring, a cushion, or simply detached glands upon the receptacle. The calyx is, however, in some cases adherent to the ovary, which is then inferior, the stamens may be perigynous and the disk may be absent. The petals form a single whorl and the stamens are generally definite in number. The series includes, as the table in the last lesson shows, four cohorts, the *Geraniales*, *Olacales*, *Celastrales*, and *Sapindales*, the first of which includes by far the greatest variety of orders and no doubt also of species.

The cohort *Geraniales* has flowers usually pentamerous throughout but often monosymmetric, with carpels opposite to the petals, syncarpous and with one or two ovules in each chamber. The typical formula is 5. 5. 5 + 5. (5). There are no fewer than eleven natural orders in this cohort that demand special notice, viz., *Lineæ*, *Erythroxyleæ*, *Oxalideæ*, *Geraniaceæ*, *Balsamineæ*, *Tropæoleæ*, *Limnantheæ*, *Rutaceæ*, *Aurantiaceæ*, *Simarubeæ*, and *Meliaceæ*. The *Lineæ*, or flax tribe, are herbs with wiry annual or perennial stems with very tough bast; simple, sessile, exstipulate and entire leaves, mostly small; polysymmetric flowers; persistent, imbricate sepals; caducous, contorted petals, often of brilliantly pure blue, red, or yellow colour; the inner row of stamens represented by staminodes; and the five loculi of the ovary almost converted into ten by the ingrowth of the midribs of the carpels. Some species of *Linum* are dimorphously heterogonous. *Linum usitatissimum*, the flax, appropriately thus named "the most useful," has been cultivated for the sake of its fibre since prehistoric times, as is shown by remains in the Swiss lake-dwellings. In Egypt also we know it to have been grown for ages. We import both flax and its seed ("linseed") mainly from Russia. The testa is mucilaginous, swelling up when moistened and thus acting as a demulcent; and the embryo yields a drying oil, largely used by painters. Belonging to a closely related tribe is *Erythroxylon Coca*, a Peruvian tree, the leaves of which are chewed by the Indians as an aid in the digestion of the starchy sweet-potato. From these leaves the anæsthetic cocaine is extracted. The *Oxalideæ*, which take their name from the considerable quantity of acid potassium oxalate that they contain, are mostly herbaceous plants, having, owing to the presence of this salt, an agreeably refreshing, sub-acid taste. Their leaves are compound and exstipulate, often ternate and exhibiting more or less the phenomena of irritability and "sleep." At night, in cloudy weather, or when irritated, their leaflets hang folded in a vertical plane, from which position they may rise to their *diurnal* horizontal position, the movement being effected by the flow of sap through perforations in the cell-walls from one side

Fig. 22.—Hedge-garlic (*Sisymbrium Alliaria*). A, Inflorescence and Cauline Leaves. B, Radical Leaf and Root.

to the other of a swelling at the base of each leaflet. Some of the flowers are cleistogamous, as in the violet, and in other cases dimorphic or trimorphic heterogony occurs, the five styles being, on different individual plants of a species, either of the same length as the five long outer stamens, or as the five shorter inner ones, or of intermediate length. *Oxalis Acetosella*, the wood-sorrel, the English name of which also alludes to its acidity, is our commonest species. The *Geraniaceæ* are mostly herbaceous plants with stipulate, petiolate leaves, generally simple and palmately veined. The flowers are commonly in an umbellate cyme with an involucre of membranous bracts, and are pentamerous and diplostemonous. The calyx persists; the stamens are more or less monadelphous; and the fruit is the characteristic regma with a long fluted carpophore, from which the styles separate when ripe, and which gives to the chief genera names derived from long-billed birds such as *Geranium* ("crane's-bill"), *Erodium* ("stork's-bill"), and *Pelargonium* ("heron's-bill"). Each carpel contains two ovules, only one of which becomes a seed. The seeds are exalbuminous. The family belongs mainly to warm climates, *Geranium*, of which there are several British species, being essentially northern, and *Pelargonium* essentially southern and mainly South African. These two apparently similar genera differ in the symmetry of their flowers, *Geranium* being polysymmetric, whilst in *Pelargonium* the posterior sepal is larger than the rest and has a nectariferous spur adherent to the pedicel, forming a little tube, sometimes an inch long, the entrance to which can be readily seen on removing the petals. This spur renders the flower monosymmetric, and sometimes the two posterior petals are coloured differently from the others. Our so-called "scarlet geraniums" and most of the species in cultivation, are truly pelargoniums.

ALGEBRA.—VII.

[Continued from Vol. IV., p. 351.]

SIMPLE EQUATIONS (*continued*).

NUMERICAL SUBSTITUTION.

170. In the reduction of an equation, as well as in other parts of algebra, a *complicated* process can often be rendered *simpler* by using letters for the given numbers, and also by introducing a *new letter* which shall be made to represent a *simple algebraic expression*. This process is called SUBSTITUTION. When the algebraic operation is completed, the *numbers*, or the *compound quantity* for which a *single* letter has been substituted, must be restored, in order to obtain the numerical value.

EXAMPLE.—Reduce $\frac{x}{750}+\frac{3}{375}=1$.

Here, by substituting a for 750, b for 3, and c for 375, the equation becomes $\frac{x}{a}+\frac{b}{c}=1$. Now, clearing fractions, we have $cx+ab=ac$, or $cx=ac-ab$, or $x=a-\frac{ab}{c}$. On restoring the numbers, we have $x=750-\frac{3\times 750}{375}=744$. *Ans.*

EXERCISE 28.

[To be worked by the process of substitution explained in Art. 170.]

1. Reduce $\frac{3x}{4}+6=84$.
2. Reduce $\frac{x}{350}+\frac{4500}{7000}=10$.
3. Reduce $\frac{x}{m+n}+\frac{a}{c}=b$.
4. Reduce $\frac{x}{l-m-n}+\frac{d}{c}=ab$.
5. Reduce $\frac{x}{m}-\frac{a}{b+c+d}=cd$.
6. Reduce $\frac{3x}{4}+6=\frac{5x}{8}+7$.
7. Reduce $\frac{x}{a}+h=\frac{x}{b}-\frac{x}{c}+d$.
8. Reduce $40-6x-16=120-14x$.
9. Reduce $\frac{x-3}{2}+\frac{x}{3}=20-\frac{x-19}{2}$.
10. Reduce $\frac{x}{3}+\frac{x}{5}=20-\frac{x}{4}$.
11. Reduce $\frac{1-a}{x}-4=5$.
12. Reduce $\frac{3}{x+4}-2=8$.
13. Reduce $\frac{6x}{x+4}=1$.
14. Reduce $x+\frac{x}{2}+\frac{x}{3}=11$.
15. Reduce $\frac{x}{2}+\frac{x}{3}+\frac{x}{4}=\frac{7}{10}$.
16. Reduce $\frac{x-5}{4}+6x=\frac{284-x}{5}$.
17. Reduce $3x+\frac{2x+6}{5}=5+\frac{11x-37}{2}$.
18. Reduce $\frac{6x-4}{3}-2=\frac{18-4x}{3}+x$.
19. Reduce $21+\frac{3x-11}{16}=\frac{5x-5}{8}+\frac{97-7x}{2}$.
20. Reduce $3x-\frac{x-4}{4}-4=\frac{5x+14}{3}-\frac{1}{12}$.
21. Reduce $\frac{7x+5}{3}-\frac{16+4x}{5}+6=\frac{3x+9}{2}$.
22. Reduce $\frac{17+3x}{5}-\frac{4x+2}{3}=5-6x+\frac{7x+14}{3}$.
23. Reduce $x-\frac{3x-3}{5}+4=\frac{20-x}{2}-\frac{6x-8}{7}+\frac{4x-4}{5}$.
24. Reduce $\frac{6x+7}{9}+\frac{7x-13}{6x+3}=\frac{2x+4}{3}$.
25. Reduce $\frac{5x-4}{2}:\frac{18-x}{4}::7:4$.
26. Reduce $2x-9=72+\frac{x}{5}$.

27. Reduce $3x - 11 = \frac{x+2}{5} + 7$.

28. Reduce $\frac{x}{2} - 1 = \frac{x}{3} + 1$.

29. Reduce $11 - \frac{x}{3} = 13 - \frac{x}{4}$.

30. Reduce $\frac{x+1}{4} + \frac{x-1}{6} = 8$.

31. Reduce $\frac{x-3}{8} + \frac{x+9}{12} = \frac{3x+7}{20} + 3$.

32. Reduce $\frac{2x}{3} + \frac{4x}{5} - \frac{6x}{7} = \frac{x}{2} + \frac{3x}{4} - \frac{5x}{6} + 81$.

33. Reduce $\frac{x-1}{2} + \frac{x-2}{3} - \frac{x-3}{4} = 6$.

SOLUTION OF PROBLEMS.

171. For the solution of problems in Simple Equations we derive from the preceding principles the following general rule:—

RULE.—1. *Translate the statement of the question from the ordinary language into algebraic language, in such a manner as to form an equation; that is, put the question into the form of an equation.*

2. *Clear the equation of fractions by multiplying every term in both members by all the denominators successively, or by their least common multiple.*

3. *Transpose all the terms containing the unknown quantity to the one side of the equation, and all the known quantities to the other, taking care to change the signs of the terms transposed, and incorporate the terms that are alike.*

4. *Remove the co-efficient of the unknown quantity, by dividing all the terms in the equation by it: the result will be the solution required.*

PROOF.—*Substitute the value of the unknown quantity for the letter which stands for it in the equation: and if the number satisfies the conditions of the question, it is the answer sought.*

PROBLEM 1.—A man being asked how much he gave for his watch, replied: If you multiply the price by 4, to the product add 70, and from this sum subtract 50, the remainder will be equal to 220 pounds.

In order to solve this question, we must first translate the conditions of the problem into such an algebraic expression as will form an *equation.*

Let x be the price of the watch.

This price is to be multiplied by 4, which makes $4x$; to the product 70 is to be added, making $4x + 70$; from this, 50 is to be subtracted, making $4x + 70 - 50$.

Here we have a number of the conditions, expressed in algebraic terms; but we have as yet no *equation.* We must observe, then, that by the last condition of the problem, the preceding terms are said to be equal to 220.

We have, therefore, this equation, $4x + 70 - 50 = 220$; which reduced, gives $x = 50$. *Ans.*

Here the value of x is found to be 50 pounds, which is the price of the watch.

PROOF.—The original equation is $4x + 70 - 50 = 220$: substituting 50 for x, it becomes $4 \times 50 + 70 - 50 = 220$: that is, $220 = 220$.

PROBLEM 2.—What number is that to which, if its half be added, and from the sum 20 be subtracted, the remainder will be a fourth of the number itself?

In stating questions of this kind, where fractions are concerned, it should be recollected that $\frac{1}{3}x$ is the same as $\frac{x}{3}$; that $\frac{2}{5}x = \frac{2x}{5}$, etc.

Let x be the number required.

Then by the conditions, we have $x + \frac{x}{2} - 20 = \frac{x}{4}$, and reducing the equation, we have $x = 16$. *Ans.*

PROOF.—Thus $16 + \frac{16}{2} - 20 = \frac{16}{4}$.

PROBLEM 3.—A father divides his estate among his three sons in such a manner that the first has £1,000 less than the whole; the second has £800 less than one-third of the whole; the third has £600 less than one-fourth of the whole. What is the value of the estate? *Ans.* £1,114$\frac{2}{7}$.

PROBLEM 4.—Divide 48 into two such parts, that if the less be divided by 4, and the greater by 6, the sum of the quotients will be 9.

Let x be the smaller part; then $48 - x$ is the greater part; and, by the conditions of the problem, we have $\frac{x}{4} + \frac{48 - x}{6} = 9$. Whence $x = 12$; therefore, 12 is the less part, and 36 the greater part.

172. Letters may be employed to express the *known* quantities in an equation, as well as the unknown. A particular value is assigned to the letters when they are introduced into the calculation; and at its close, the numbers are restored.

EXAMPLE.—If to a certain number 720 be added, and the sum be divided by 125, the quotient will be equal to 7392 divided by 462. What is the number?

Let x be the number required; and let $a = 720$, $b = 125$, $d = 7392$, and $h = 462$.

Then, by the conditions of the problem, we have $\frac{x + a}{b} = \frac{d}{h}$; and reducing, we have $x = \frac{bd - ah}{h}$.

Restoring the numbers, we have $x =$

$$\frac{(125 \times 7392) - (720 \times 462)}{462} = 1280.$$

EXERCISE 29.—MISCELLANEOUS PROBLEMS IN SIMPLE EQUATIONS.

1. Divide 11 into two parts, such that the sum of twice the first and half the second may be 16.

2. Divide 39 into four parts, such that if the first be increased by 1, the second diminished by 2, the third multiplied

by 3, and the fourth divided by 4, the results may all be equal.

3. If a certain number is divided by 12, the quotient, dividend, and divisor, added together, will amount to 64. What is the number?

4. An estate is divided among four children in such a manner that the first has £200 more than $\frac{1}{4}$ of the whole, the second has £340 more than $\frac{1}{5}$ of the whole, the third has £300 more than $\frac{1}{6}$ of the whole, and the fourth has £400 more than $\frac{1}{8}$ of the whole. What is the value of the estate?

5. What is that number which is as much less than 500 as a fifth part of it is greater than 40?

6. There are two numbers whose difference is 40, and which are to each other as 6 to 5. What are the numbers?

7. Suppose two coaches to start at the same hour, one from London for Glasgow, and the other from Glasgow for London, the former travelling 10½ and the latter 9½ miles per hour. Where will they meet, the distance between the two cities being 400 miles?

8. Suppose everything to be as in the last question, except that the coach from Glasgow starts two hours earlier than the other. Where will they meet?

9. A dealer purchases 60 yards of cloth for £30; and by selling one part of it at 12s., another, twice as great, at 11s., and the rest at 10s. per yard, he gains £8. How many yards were in the several lots?

10. Suppose two dealers each annually to double his capital, except an expenditure of £100; and that at the end of three years the capital of one is found to be doubled, while the other has only half of what he had at first. How much had each to commence with?

11. If a person each year double his capital, except an expenditure of £300 the first year, £400 the next year, and £500 the third, and at the end of three years be found to be worth £5,500, what was his original capital?

12. A father's age is now treble of his son's, while five years ago it was quadruple. What are their present ages?

13. Divide £1,000 between A, B, and C, giving A £100 more and B £50 less than C.

14. A spirit merchant finds that if he add 10 gallons to a cask of brandy, the mixture will be worth 21s. per gallon; but that if he add ten gallons more, the value will be reduced to 18s. How many gallons were in the cask?

15. Find a number, such that if it be divided successively by 2, 3, 4, 5, 6, 7, 8, 9, and 10, half the sum of the first four quotients increased by 20 shall be equal to the sum of the remaining five.

16. Find two numbers differing by 6, and such that three times the less may exceed twice the greater by 7.

17. Find a number, such that if it be increased successively by 1, 2, and 3, the sum of one-half of the first result and one-third of the second shall exceed one-fourth of the third by 8.

Exercise 30.—Miscellaneous Problems in Simple Equations.

1. What two numbers are those whose difference is 10; and if 15 be added to their sum, the amount will be 43?

2. There are two numbers whose difference is 14; and if 9 times the less be subtracted from 6 times the greater, the remainder will be 33. What are the numbers?

3. What number is that, to which if 20 be added, and from $\frac{2}{3}$ of this sum 12 be subtracted, the remainder will be 10?

4. A and B lay out equal sums of money in trade; A gains £120, and B loses £80; and now A's money is triple that of B. What sum had each at first?

5. What number is that $\frac{1}{3}$ of which exceeds its $\frac{1}{4}$ by 72?

6. There are two numbers whose sum is 37; and if 3 times the less be subtracted from 4 times the greater, and the remainder be divided by 6, the quotient will be 6. What are the numbers?

7. A man has two children, to $\frac{1}{3}$ of the sum of whose ages if 13 be added, the amount will be 17; and if from half the difference of their ages 1 be subtracted, the remainder will be 2. What is the age of each?

8. A messenger being sent on business, goes at the rate of 6 miles an hour; 8 hours afterwards, another is despatched with countermanding orders, and goes at the rate of 10 miles an hour. How long will it take the latter to overtake the former?

9. Find two numbers in the proportion of 2 to 3 whose product shall be 54.

10. A man agreed to give a labourer 12s. a day for every day he worked, but for every day he was idle he should forfeit 8s. After 390 days they settled, and their account was even. How many days did he work?

11. Three persons, A, B, and C, draw prizes in a lottery. A draws £200; B draws as much as A, together with a third of what C draws; and C draws as much as A and B both. What is the amount of the three prizes?

12. What number is that which is to 12 increased by three times the number, as 2 to 9?

13. A ship and a boat are descending the river at the same time. The ship passes a certain fort when the boat is 13 miles below. The ship descends 5 miles while the boat descends 3. At what distance below the fort will they be together?

14. What number is that, a sixth part of which exceeds an eighth part of it by 20?

15. Divide a prize of £2,000 into two such parts that one of them shall be to the other as 9 to 7.

16. What sum of money is that whose third part, fourth part, and fifth part, added together, amount to £94?

17. Two travellers, A and B, 360 miles apart, travel towards each other till they meet. A's progress is 10 miles an hour, and B's 8. How far does each travel before they meet?

18. A man spent one-third of his life in England, one-fourth of it in Scotland, and the remainder of it, which was 20 years, in the United States. To what age did he live?

19. What number is that $\frac{3}{4}$ of which is greater than $\frac{1}{4}$ of it by 96?

20. A post is $\frac{1}{4}$ in the earth, $\frac{1}{3}$ in the water, and 13 feet above the water. What is the length of the post?

21. What number is that, to which 10 being added, $\frac{3}{4}$ of the sum will be 66?

22. Of the trees in an orchard, $\frac{1}{3}$ are apple-trees, $\frac{1}{10}$ pear-trees, and the remainder peach-trees, which are 20 more than $\frac{1}{2}$ of the whole. What is the whole number of trees in the orchard?

23. A gentleman bought several gallons of wine for £94; and after using 7 gallons himself, sold $\frac{4}{5}$ of the remainder for £20. How many gallons had he at first?

24. A and B have the same income. A contracts an annual debt amounting to $\frac{1}{7}$ of it; B lives upon $\frac{4}{5}$ of it; at the end of ten years B lends to A enough to pay off his debts, and has £160 to spare. What is the income of each?

25. A gentleman lived single $\frac{1}{4}$ of his whole life; and after having been married 5 years more than $\frac{1}{3}$ of his life, he had a son, who died 4 years before him, and who reached only half the age of his father. To what age did the father live?

26. What number is that of which, if $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{2}{7}$ be added together, the sum will be 73?

27. A person after spending £100 more than $\frac{1}{3}$ of his income, had remaining £35 more than $\frac{1}{2}$ of it. Required his income.

28. In the composition of a quantity of gunpowder, the *nitre* was 10lb. more than $\frac{2}{3}$ of the whole, the *sulphur* 4½lb. less than $\frac{1}{6}$ of the whole, the *charcoal* 2lb. less than $\frac{1}{7}$ of the whole. What was the amount of gunpowder?

29. A cask which held 146 gallons was filled with a mixture

of brandy, wine, and water. There were 15 gallons of wine more than of brandy, and as much water as the brandy and wine together. What quantity was there of each?

30. Four persons purchased a farm in company for £4,775; of which B paid three times as much as A; C paid as much as A and B; and D paid as much as C and B. What did each pay?

31. It is required to divide the number 99 into five such parts that the first may exceed the second by 3, be less than the third by 10, greater than the fourth by 9, and less than the fifth by 16.

32. A father divided a small sum among four sons; the third had 9 shillings more than the fourth, the second had 12 shillings more than the third, the first had 18 shillings more than the second, and the whole sum was 6 shillings more than 7 times the sum which the youngest received. What was the sum divided?

33. A farmer had two flocks of sheep, each containing the same number. Having sold from one of these 39, and from the other 93, he finds twice as many remaining in the former as in the latter. How many did each flock originally contain?

34. An express travelling at the rate of 60 miles a day had been despatched 5 days, when a second was sent after him, travelling 75 miles a day. In what time will the one overtake the other?

35. A's age is double that of B, and B's age triple that of C, and the sum of all their ages 140. What is the age of each?

36. Two pieces of cloth, at the same price by the yard, but of different lengths, were bought, the one for £5, and the other for £6½. If 10 yards be added to the length of each, the sums will be as 5 to 6. Required the length of each piece.

37. A and B began trade with equal sums of money. The first year A gained £40, and B lost £40. The second year A lost ⅓ of what he had at the end of the first, and B gained £40 less than twice the sum which A had lost. B had then twice as much money as A. What sum did each begin with?

38. What number is that which, being severally added to 36 and 52, will make the former sum to the latter as 3 to 4?

39. A gentleman bought a chaise, horse, and harness for £360. The horse cost twice as much as the harness, and the chaise cost twice as much as the harness and horse together. What was the price of each?

40. Out of a cask of wine, from which had leaked ¼ part, 21 gallons were afterwards drawn, when the cask was found to be half full. How much did it hold?

41. A man has 6 sons, each of whom is four years older than his next younger brother, and the eldest is three times as old as the youngest. What is the age of each?

42. Divide the number 49 into two such parts, that the greater increased by 6 shall be to the less diminished by 11, as 9 to 2.

43. What two numbers are as 2 to 3; to each of which, if 4 be added, the sums will be as 5 to 7?

44. A person bought two casks of porter, one of which held just three times as much as the other; from each of these he drew 4 gallons, and then found that there were 4 times as many gallons remaining in the larger as in the other. How many gallons were there in each?

45. Divide the number 68 into two such parts, that the difference between the greater and 84 shall be equal to 3 times the difference between the less and 40.

46. Four places are situated in the order of the letters A, B, C, D. The distance from A to D is 34 miles. The distance from A to B is to the distance from C to D as 2 to 3; and ¼ of the distance from A to B, added to half the distance from C to D, is three times the distance from B to C. What are the respective distances?

47. Divide the number 36 into three such parts, that ½ of the first, ⅓ of the second, and ¼ of the third, shall be equal to each other.

48. A merchant supported himself 3 years for £50 a year, and at the end of each year added to that part of his stock which was not thus expended a sum equal to ⅓ of this part. At the end of the third year his original stock was doubled. What was that stock?

49. A general having lost a battle, found that he had only half of his army + 3,600 men left fit for action; ⅛ of the army + 600 men being wounded; and the rest, who were ⅕ of the whole, either slain, taken prisoners, or missing. Of how many men did his army consist?

50. To find a number to the sum of whose digits if 7 be added, the result will be 3 times the left-hand digit; and if from the number itself 18 be taken, the digits will be inverted.

51. To find a number consisting of two digits, the sum of which is 5; and if 9 be added to the number itself, the digits will be inverted.

52. There is a certain fraction such that if you add 1 to its numerator, it becomes ⅓; but if you add 3 to its denominator, it becomes ¼. Required the fraction.

53. It is required to find two numbers whose difference is 7, and their sum 33.

54. At a town meeting 375 votes were cast, and the person elected to office had a majority of 91. How many votes had each candidate?

55. A post stands ¼ in the ground, ⅓ in the water, and 10 feet above the water. What is the whole length of it?

56. A young man, the first day after his arrival in London, spent ⅓ of his money, the second day ¼, the third day ⅙, and he then had only 20 pence left. How much did he have at first?

57. A person being asked his age, answered that ¾ of his age multiplied by $\frac{1}{12}$ of his age would give a product equal to his age. How many years old was he?

58. A man leased a house for 99 years; and being asked how much of the time had expired, replied that ⅔ of the time past was equal to ⅘ of the time to come. How many years had expired?

59. On commencing the study of his profession, a man found that ⅐ of his life had been spent before he learnt his letters, ⅙ at a public school, ½ at an academy, and 4 years at college. How old was he?

60. It is required to find a number such that whether it be divided into two equal parts or three equal parts, the product of its parts will be equal.

61. Two persons, 154 miles apart, set out at the same time to meet each other, one travelling at the rate of 3 miles in 2 hours, the other 5 miles in 4 hours. How long will it be before they meet?

62. A man and his wife usually drank a cask of beer in 12 days, but when the man was absent it lasted the wife 30 days. How long would it last the man if his wife were absent?

63. A shepherd being asked how many sheep he had, replied if he had as many more, half as many more, and 7½ sheep, he would then have 500. How many had he?

64. A farmer hired two men to do a job of work for him; one could do the work in 10 days, the other in 15. How long would it take both together to do the same job?

65. A and B together can build a boat in 20 days; with the assistance of C they can do it in 12 days. How long would it take C to build the boat?

66. There is a cistern with two aqueducts; one will fill it in 30 minutes, the other will empty it in 40. How long will it take to fill it if both run together?

67. Required to divide 1 shilling into pence and farthings in such a proportion that there may be 39 pieces.

68. A man divided a small sum of money among his children in the following manner: viz., to the first he gave $\frac{1}{8}$ of the whole + 4 pence, to the second $\frac{1}{8}$ of the remainder + 8 pence, to the third $\frac{1}{8}$ of the remainder + 12 pence, and so on, giving to all an equal sum till he had distributed the whole. Required the number of shares and the sum distributed.

69. A hare has 50 leaps the start of a hound, and takes 4 leaps while the hound takes 3; but 2 leaps of the hound are equal to 3 of the hare. How many leaps will the hound take in catching the hare?

70. A and B start at the same time and place to go round an island 600 miles in circumference. A goes 30 miles a day, and B 20. How long before they will both be at the starting-point together, and how far will each have travelled?

71. A has £100, B £48. A robber takes twice as much from A as from B. A now has 3 times as much as B. What was taken from each?

72. It is required to divide £1,200 between A, B, and C; B has £250 + $\frac{1}{3}$ of A's share; C has £270 + $\frac{1}{3}$ of B's. What was the share of each?

73. There are three pieces of cloth of different value. The average price of the first and second is 7s. per yard, that of the second and third is 9s., and the average price of all is $\frac{7}{8}$ of the third. What are the several prices?

74. A pipe will fill a cistern in 11 hours. After running 5 hours another is opened, and then the two fill it in 2 hours. In what time would the last fill it?

75. A man bought a cask of wine, and $\frac{1}{5}$ of it leaking out, he sold the rest at 25s. per gallon, and neither gained nor lost by his bargain. What did he give per gallon for his wine?

76. Find a fraction, such that if its denominator be increased by 1, the value becomes $\frac{1}{3}$; while if the numerator be increased by 1, the value is $\frac{1}{2}$.

77. Required a fraction, such that if the numerator and denominator be each increased by 1, the value is changed into $\frac{1}{2}$; but if they be each diminished by 1, the value becomes $\frac{1}{3}$.

78. One person says to another, "If you give me half your money, I shall have a hundred pounds." The other replies, "I shall have a hundred pounds if you give me a third of your money." How much had each?

KEY TO EXERCISES.

Exercise 21.

1. $\frac{8bd}{2cm}$.
2. $\frac{4ah + 4dh}{my - 2y}$.
3. $\frac{4ah + 4hm}{3a - 3n}$.
4. $\frac{4a + 4h - am - hm}{3c + cd + 3y + dy}$.
5. $\frac{3}{8a + 24r}$.
6. $\frac{acm}{bdy}$.
7. $\frac{2abh - 2abd}{cmry - cmy}$.
8. $\frac{9 + 8b}{7hm}$.
9. $\frac{3a^2d - 18ad^2}{7dhy + 7hy}$.
10. $\frac{ch}{6}$.
11. $\frac{cm + dm}{ch}$.
12. $\frac{3amr + 3dr}{bam}$.
13. $3m$.
14. $h + 3d$.
15. $\frac{a}{b}$.
16. $\frac{h}{4}$.

Exercise 22.

1. $\frac{4a^3}{21}$.
2. $\frac{ax + x^2}{a^2 - ax}$.
3. $\frac{5x^2}{2b}$.
4. $\frac{3x + y}{3a + 4c}$.
5. $\frac{a + b}{4 + 5y}$.
6. $\frac{4a}{b}$.
7. 1.
8. $\frac{y}{x}$.
9. $\frac{3c}{4d}$.
10. $\frac{a^2 - b^2}{12}$.
11. $2abx$.
12. $\frac{9by}{4}$.
13. $x^3 - ax^2 - a^2x - 2a^3$.
14. $\frac{a^4b}{(x - n)^2}$.
15. $\frac{1 - n^3}{1 + b^3}$.
16. $\frac{4xy}{x^2 - y^2}$.
17. $\frac{18x^6 + 19x^4 - 93x^2 + 36}{36x^6 - 52x^4 + 96x^3 - 43x^2 + 12}$.

Exercise 23.

1. $\frac{xy + dy}{5dr}$.
2. $\frac{ad}{rx}$.
3. $\frac{4dy}{h}$.
4. $\frac{abx + a}{3aby - 3y}$.
5. $\frac{ah - amy + h - my}{12}$.
6. $\frac{1}{ah - bh}$.
7. $\frac{1}{8}$.
8. $\frac{2xy}{a + b}$.
9. $\frac{4abd + 4cdx}{am}$.
10. $\frac{9ac - 3x}{a}$.

Exercise 24.

1. $\frac{c}{x - y}$.
2. $\frac{2x + 3b}{10 - y}$.
3. $\frac{3x + 11}{3dx}$.
4. $\frac{a + 1 - x}{2al^2}$.
5. $\frac{ab + b^2}{ax}$.
6. $\frac{4r + 2mr}{3aby}$.
7. $\frac{a^2 + 2ab + b^2}{12}$.
8. $\frac{x + y}{h}$.
9. 1.
10. $3cr$.
11. $\frac{4cry}{ab}$.
12. $\frac{27rm}{x - y}$.
13. $\frac{6am + 6mx}{n^2 - ap}$.
14. $\frac{4ax + 6c + 2d}{2x^2 + xy + bx}$.
15. $\frac{c^4}{a^3}$.
16. $\frac{6x^2 - x - 1}{x^2 - x - 6}$.
17. $\frac{y^4 + 2y}{y^2 - 3y + 2}$.
18. $\frac{n^4 - b^4}{a^2 - c^2}$.
19. $\frac{x^3 + ax^2}{a^3}$.
20. $\frac{m^2}{n^2}$.
21. $\frac{a}{a - 1}$.
22. $\frac{y^2}{x - b}$.
23. $\frac{x^4 - b^4}{ax^4 - a^3}$.
24. $\frac{a^2(x^2 - a^2)}{x^4 + a^2x^2}$.
25. $\frac{x^2 + a^2}{1 + 2x}$.
26. $\frac{3x^2 + 4x - 2}{x}$.

Exercise 25.

1. $x = b + 4$.
2. $y = 2ab - 2ha - a$.
3. $x = b - 7h - d - 22$.
4. $x = 3bh + 9$.
5. $x = 15$.
6. $x = 11$.
7. $x = 20$.
8. $x = 31$.
9. $x = 8$.
10. $x = 6$.
11. $x = 7$.
12. $x = 4$.
13. $y = 18$.
14. $x = 24$.

Exercise 26.

1. $x = 94$.
2. $x = (a + b) \times (h - d)$.
3. $x = 4$.
4. $x = \frac{abgm + adem - adgh}{dgm}$.
5. $x = 9 - \frac{1}{11}$, or $x = 8\frac{10}{11}$.
6. $x = 72$.
7. $x = 7$.
8. $x = 10$.
9. $x = 70$.

Exercise 27.

1. $x = \frac{1}{4}\left(\frac{a}{c} - \frac{d}{h}\right) + 2b$.
2. $x = \frac{h - 4}{a + 1}$.
3. $x = \frac{(a + d)h - 4b}{4(h - 1)}$.
4. $x = d + 1$.
5. $y = \frac{c(h - m)}{a + b}$.
6. $a + b : h - m :: c : y$.
7. $x = 2$.
8. $x = 3$.
9. $x = 12$.
10. $x = 2$.

FRENCH.—XXV.

[Continued from Vol. IV., p. 360.]

ALPHABETICAL TABLE

OF THE IRREGULAR, DEFECTIVE, PECULIAR, AND IMPERSONAL VERBS (continued).

The figures placed after the infinitive of the verbs indicate the conjugations to which they belong.—The tenses not given in this Table are not used.

Infinitive.	Participles.	Indicative. Present.	Indicative. Imperfect.	Indicative. Past Definite.	Indicative. Future.	Conditional Present.	Imperative.	Subjunctive. Present.	Subjunctive. Imperfect.
COLLETER, 1, *to collar*	colletant colleté, *f.* -e	je collète	je colletais see ACHETER	je colletai	je collèterai	je collèterais	collète	je collète	je colletasse
COMBATTRE, 4, *to combat*	combattant combattu, *f.* -e	je combats see BATTRE	je combattais	je combattis	je combattrai	je combattrais	combats	je combatte	je combattisse
COMMETTRE, 4, *to commit*	commettant commis, *f.* -e	je commets see METTRE	je commettais	je commis	je commettrai	je commettrais	commets	je commette	je commisse
COMPARAÎTRE, 4, *to appear*	comparaissant comparu	je comparais see PARAÎTRE	je comparaissais	je comparus	je comparaîtrai	je comparaîtrais	comparais	je comparaisse	je comparusse
COMPLAIRE, 4, *to humour*	complaisant complu	je complais see PLAIRE	je complaisais	je complus	je complairai	je complairais	complais	je complaise	je complusse
COMPRENDRE, 4, *to understand*	comprenant compris, *f.* -e	je comprends see PRENDRE	je comprenais	je compris	je comprendrai	je comprendrais	comprends	je comprenne	je comprisse
COMPROMETTRE, 4, *to compromise*	compromettant compromis, *f.* -e	je compromets see METTRE	je compromettais	je compromis	je compromettrai	je compromettrais	compromets	je compromette	je compromisse
CONCLURE, 4, *to conclude* aux. avoir irregular	concluant conclu, *f.* -e	je conclus tu conclus il conclut n. concluons v. concluez ils concluent	je concluais tu concluais il concluait n. concluions v. concluiez ils concluaient	je conclus tu conclus il conclut n. conclûmes v. conclûtes ils conclurent	je conclurai tu concluras il conclura n. conclurons v. conclurez ils concluront	je conclurais tu conclurais il conclurait n. conclurions v. concluriez i. concluraient	conclus qu'il conclue concluons concluez q. i. concluent	je conclue tu conclues il conclue n. concluions v. concluiez ils concluent	je conclusse tu conclusses il conclût n. conclussions v. conclussiez ils conclussent
CONCOURIR, 2, *to concur*	concourant concouru, *f.* -e	je concours see COURIR	je concourais	je concourus	je concourrai	je concourrais	concours	je concoure	je concourusse
CONDUIRE, 4, *to conduct* aux. avoir irregular	conduisant conduit, *f.* -e	je conduis tu conduis il conduit n. conduisons v. conduisez i. conduisent	je conduisais tu conduisais il conduisait n. conduisions v. conduisiez i. conduisaient	je conduisis tu conduisis il conduisit n. conduisîmes v. conduisîtes i. conduisirent	je conduirai tu conduiras il conduira n. conduirons v. conduirez ils conduiront	je conduirais tu conduirais il conduirait n. conduirions v. conduiriez i. conduiraient	conduis q. i. conduise conduisons conduisez q. i. conduisent	je conduise tu conduises il conduise n. conduisions v. conduisiez ils conduisent	je conduisisse tu conduisisses il conduisît, conduisissions v. conduisissiez, i. conduisissent
CONFIRE, 4, *to preserve* aux. avoir irregular	confisant confit, *f.* -e	je confis tu confis il confit n. confisons v. confisez ils confisent	je confisais tu confisais il confisait n. confisions v. confisiez ils confisaient	je confis tu confis il confit n. confîmes v. confîtes ils confirent	je confirai tu confiras il confira n. confirons v. confirez ils confiront	je confirais tu confirais il confirait n. confirions v. confiriez ils confiraient	confis qu'il confise confisons confisez q. i. confisent	je confise tu confises il confise n. confisions v. confisiez ils confisent	je confisse tu confisses il confît n. confissions v. confissiez ils confissent
CONGELER, 1, *to congeal*	congelant congelé, *f.* -e	je congèle	je congelais	je congelai	je congèlerai	je congèlerais	congèle	je congèle	je congelasse
CONJOINDRE, 4, *to conjoin*	conjoignant conjoint, *f.* -e	je conjoins see CRAINDRE	je conjoignais	je conjoignis	je conjoindrai	je conjoindrais	conjoins	je conjoigne	je conjoignisse
CONNAÎTRE, 4, *to know* aux. avoir irregular	connaissant connu, *f.* -e	je connais tu connais il connaît n. connaissons v. connaissez ils connaissent	je connaissais tu connaissais il connaissait n. connaissions v. connaissiez ils connaissaient	je connus tu connus il connut n. connûmes v. connûtes ils connurent	je connaîtrai tu connaîtras il connaîtra n. connaîtrons v. connaîtrez ils connaîtront	je connaîtrais tu connaîtrais il connaîtrait n. connaîtrions v. connaîtriez ils connaîtraient	connais q. i. connaisse connaissons connaissez qu'ils connaissent	je connaisse tu connaisses il connaisse n. connaissions v. connaissiez ils connaissent	je connusse tu connusses il connût n. connussions v. connussiez ils connussent
CONQUÉRIR, 2, *to conquer*	conquérant conquis, *f.* -e	je conquiers see ACQUÉRIR	je conquérais	je conquis	je conquerrai	je conquerrais	conquiers	je conquière	je conquisse

Infinitive.	Participles.	Indicative. Present.	Indicative. Imperfect.	Indicative. Past Definite.	Indicative. Future.	Conditional Present.	Imperative.	Subjunctive. Present.	Subjunctive. Imperfect.
CONSENTIR, 2, *to consent*	consentant consenti, *f.* -e	je consens *see* SENTIR	je consentais	je consentis	je consentirai	je consentirais	consens	je consente	je consentisse
CONSTRUIRE, 4, *to construct*	construisant construit, *f.* -e	je construis *see* CONDUIRE	je construisais	je construisis	je construirai	je construirais	construis	je construise	je construisisse
CONTENIR, 2, *to contain*	contenant contenu, *f.* -e	je contiens *see* TENIR	je contenais	je contins	je contiendrai	je contiendrais	contiens	je contienne	je continsse
CONTRAINDRE, 4, *to constrain*	contraignant contraint, *f.* -e	je contrains *see* CEINDRE	je contraignais	je contraignis	je contraindrai	je contraindrais	contrains	je contraigne	je contraignisse
CONTREDIRE, 4, *to contradict* aux. avoir	contredisant contredit, *f.* -e	je contredis tu contredis il contredit n. contredisons v. contredisez ils contredisent	je contredisais *like* DIRE	je contredis *like* DIRE	je contredirai *like* DIRE	je contredirais *like* DIRE	contredis q. i. contredise contredisons contredisez q. i. contredisent	je contredise	je contredisse
CONTREFAIRE, 4 *to counterfeit*	contrefaisant contrefait, *f.* -e	je contrefais *see* FAIRE	je contrefaisais	je contrefis	contreferai	je contreferais	contrefais	je contrefasse	je contrefisse
CONTREVENIR, 2, *to contravene*	contrevenant contrevenu, *f.* -e	je contreviens *see* TENIR	je contrevenais	je contrevins	je contreviendrai	je contreviendrais	contreviens	je contrevienne	je contrevinsse
CONVAINCRE, 4, *to convince*	convainquant convaincu, *f.* -e	je convaincs *see* VAINCRE	je convainquais	je convainquis	je convaincrai	je convaincrais	convaincs	je convainque	je convainquisse
CONVENIR, 2, *to suit, fit, etc.*	convenant convenu, *f.* -e	je conviens *see* TENIR	je convenais	je convins	je conviendrai	je conviendrais	conviens	je convienne	je convinsse
COQUETER, 1, *to coquet*	coquetant coqueté	je coquette *see* JETER	je coquetais	je coquetai	je coquetterai	je coquetterais	coquette	je coquette	je coquetasse
CORROMPRE, 4, *to corrupt*	corrompant corrompu, *f.* -e	je corromps *see* ROMPRE	je corrompais	je corrompis	je corromprai	je corromprais	corromps	je corrompe	je corrompisse
COUDRE, 4, *to sew* aux. avoir irregular	cousant cousu, *f.* -e	je couds tu couds il coud n. cousons v. cousez ils cousent	je cousais tu cousais il cousait n. cousions v. cousiez ils cousaient	je cousis tu cousis il cousit n. cousîmes v. cousîtes ils cousirent	je coudrai tu coudras il coudra n. coudrons v. coudrez ils coudront	je coudrais tu coudrais il coudrait n. coudrions v. coudriez ils coudraient	couds qu'il couse cousons cousez q. i. cousent	je couse tu couses il couse n. cousions v. cousiez ils cousent	je cousisse tu cousisses il cousît n. cousissions v. cousissiez ils cousissent
COURIR, 2, *to run* aux. avoir irregular	courant couru	je cours tu cours il court n. courons v. courez ils courent	je courais tu courais il courait n. courions v. couriez ils couraient	je courus tu courus il courut n. courûmes v. courûtes ils coururent	je courrai tu courras il courra n. courrons v. courrez ils courront	je courrais tu courrais il courrait n. courrions v. courriez ils courraient	cours qu'il coure courons courez q. i. courent	je coure tu coures il coure n. courions v. couriez ils courent	je courusse tu courusses il courût n. courussions v. courussiez ils courussent
COUVRIR, 2, *to cover*	couvrant couvert, *f.* -e	je couvre *see* OUVRIR	je couvrais	je couvris	je couvrirai	je couvrirais	couvre	je couvre	je couvrisse
CRAINDRE, 4, *to fear*	craignant craint, *f.* -e	je crains *see* CEINDRE	je craignais	je craignis	je craindrai	je craindrais	crains	je craigne	je craignisse
CROIRE, 4, *to believe* aux. avoir irregular	croyant cru, *f.* -e	je crois tu crois il croit n. croyons v. croyez ils croient	je croyais tu croyais il croyait n. croyions v. croyiez ils croyaient	je crus tu crus il crut n. crûmes v. crûtes ils crurent	je croirai tu croiras il croira n. croirons v. croirez ils croiront	je croirais tu croirais il croirait n. croirions v. croiriez ils croiraient	crois qu'il croie croyons croyez q. i. croient	je croie tu croies il croie n. croyions v. croyiez ils croient	je crusse tu crusses il crût n. crussions v. crussiez ils crussent
CROÎTRE, 4, *to grow* aux. avoir and être irregular	croissant crû, *f.* -e	je croîs tu croîs il croît n. croissons v. croissez ils croissent	je croissais tu croissais il croissait n. croissions v. croissiez ils croissaient	je crûs tu crûs il crût n. crûmes v. crûtes ils crûrent	je croîtrai tu croîtras il croîtra n. croîtrons v. croîtrez ils croîtront	je croîtrais tu croîtrais il croîtrait n. croîtrions v. croîtriez ils croîtraient	crois qu'il croisse croissons croissez q. i. croissent	je croisse tu croisses il croisse n. croissions v. croissiez ils croissent	je crûsse tu crûsses il crût n. crûssions v. crûssiez ils crûssent
CUEILLIR, 2, *to gather*	cueillant cueilli, *f.* -e	je cueille tu cueilles il cueille	je cueillais tu cueillais il cueillait	je cueillis tu cueillis il cueillit	je cueillerai tu cueilleras il cueillera	je cueillerais tu cueillerais il cueillerait	cueille qu'il cueille	je cueille tu cueilles il cueille	je cueillisse tu cueillisses il cueillît

		n. cueillons v. cueillez ils cueillent	n. cueillions v. cueilliez ils cueillaient	n. cueillîmes v. cueillîtes ils cueillirent	n. cueillerons v. cueillerez ils cueilleront	n. cueillerions v. cueilleriez i. cueilleraient	cueillons cueillez q.i. cueillent	n. cueillions v. cueilliez ils cueillent	n. cueillissions v. cueillissiez ils cueillissent
CUIRE, 4, *to bake, cook, etc.*	cuisant cuit, *f.* -e	je cuis *see* CONDUIRE	je cuisais	je cuisis	je cuirai	je cuirais	cuis	je cuise	je cuisisse
DÉBATTRE, 1, *to debate*	débattant débattu, *f.* -e	je débats *see* BATTRE	je débattais	je débattis	je débattrai	je débattrais	débats	je débatte	je débattisse
DÉCACHETER, 1, *to unseal*	décachetant décacheté, *f.* -e	je décachette	je décachetais	je décachetai	je décachetterai	je décachetterais	décachette	je décachette	je décachetasse
DÉCHOIR, 3, *to decay*, aux. avoir and être, defective	déchu, *f.* -e	je déchois tu déchois il déchoit n. déchoyons v. déchoyez ils déchoient		je déchus tu déchus il déchut n. déchûmes v. déchûtes ils déchurent	je décherrai tu décherras il décherra n. décherrons v. décherrez ils décherront	je décherrais tu décherrais il décherrait n. décherrions v. décherriez ils décherraient	déchois qu'il déchoie déchoyons déchoyez q.i. déchoient	déchoie tu déchoies il déchoie n. déchoyions v. déchoyiez ils déchoient	je déchusse tu déchusses il déchût n. déchussions v. déchussiez ils déchussent
DÉCOUDRE, 4, *to unstitch*	décousant décousu, *f.* -e	je découds *see* COUDRE	je décousais	je décousis	je découdrai	je découdrais	découds	je découse	je décousisse
DÉCOUVRIR, 2, *to discover*	découvrant découvert, *f.* -e	je découvre *see* OUVRIR	je découvrais	je découvris	je découvrirai	je découvrirais	découvre	je découvre	je découvrisse
DÉCRIRE, 1, *to describe*	décrivant décrit, *f.* -e	je décris *see* ÉCRIRE	je décrivais	je décrivis	je décrirai	je décrirais	décris	je décrive	je décrivisse
DÉDIRE, 1, *to unsay*	dédisant dédit, *f.* -e	je dédis *see* CONTREDIRE	je dédisais *see* DIRE	je dédis *see* DIRE	je dédirai	je dédirais	dédisez	je dédise	je dédisse
DÉDUIRE, 4, *to deduct*	déduisant déduit, *f.* -e	je déduis *see* CONDUIRE	je déduisais	je déduisis	je déduirai	je déduirais	déduis	je déduise	je déduisisse
DÉFAILLIR, 2, *to fail, faint*, defective	défaillant défailli	n. défaillons* v. défaillez ils défaillent	je défaillais, etc.	je défaillis, etc.	je défaudrai, etc. (*Acad.*)	je défaudrais, etc. (*Acad.*)		je défaille, etc. (*Acad.*)	je défaillisse, etc. (*Acad.*)
DÉFAIRE, 1, *to undo*	défaisant défait, *f.* -e	je défais *see* FAIRE	je défaisais	je défis	je déferai	je déferais	défais	je défasse	je défisse
DÉGELER, 1, *to thaw*	dégelant dégelé, *f.* -e	il dégèle	il dégelait	il dégela	il dégèlera	il dégèlerait		il dégèle	il dégelât
DÉJOINDRE, 4, *to disjoin*	déjoignant déjoint, *f.* -e	je déjoins *see* CRAINDRE	je déjoignais	je déjoignis	je déjoindrai	je déjoindrais	déjoins	je déjoigne	je déjoignisse
DÉMENTIR, 2, *to belie*	démentant démenti, *f.* -e	je démens *see* SENTIR	je démentais	je démentis	je démentirai	je démentirais	démens	je démente	je démentisse
DÉMETTRE, 4, *to disjoint*	démettant démis, *f.* -e	je démets *see* METTRE	je démettais	je démis	je démettrai	je démettrais	démets	je démette	je démisse
DÉPEINDRE, 1, *to depict*	dépeignant dépeint, *f.* -e	je dépeins *see* CRAINDRE	je dépeignais	je dépeignis	je dépeindrai	je dépeindrais	dépeins	je dépeigne	je dépeignisse
DÉPLAIRE, 1, *to displease*	déplaisant déplu	je déplais *see* PLAIRE	je déplaisais	je déplus	je déplairai	je déplairais	déplais	je déplaise	je déplusse
DÉSAPPRENDRE, 4, *to unlearn*	désapprenant désappris, *f.* -e	je désapprends *see* PRENDRE	je désapprenais	je désappris	je désapprendrai	je désapprendrais	désapprends	je désapprenne	je désapprisse
DESSERVIR, 2, *to clear the table*	desservant desservi, *f.* -e	je dessers *see* SERVIR	je desservais	je desservis	je desservirai	je desservirais	dessers	je desserve	je desservisse
DÉTEINDRE, 4, *to discolour*	déteignant déteint, *f.* -e	je déteins *see* CRAINDRE	je déteignais	je déteignis	je déteindrai	je déteindrais	déteins	je déteigne	je déteignisse
DÉTENIR, 2, *to detain*	détenant détenu, *f.* -e	je détiens *see* TENIR	je détenais	je détins	je détiendrai	je détiendrais	détiens	je détienne	je détinsse
DÉTRUIRE, 4, *to destroy*	détruisant détruit, *f.* -e	je détruis *see* CONDUIRE	je détruisais	je détruisis	je détruirai	je détruirais	détruis	je détruise	je détruisisse
DEVENIR, 2, *to become*	devenant devenu, *f.* -e	je deviens *see* TENIR	je devenais	je devins	je deviendrai	je deviendrais	deviens	je devienne	je devinsse
DÉVÊTIR, 2, *to divest*	dévêtant dévêtu, *f.* -e	je dévêts *see* VÊTIR	je dévêtais	je dévêtis	je dévêtirai	je dévêtirais	dévêts	je dévête	je dévêtisse

* Je défaus, tu défaus, il défaut, are sometimes, but rarely, met with.—(*Acad.*)

Infinitive.	Participles.	Indicative. Present.	Indicative. Imperfect.	Indicative. Past Definite.	Indicative. Future.	Conditional Present.	Imperative.	Subjunctive. Present.	Subjunctive. Imperfect.
DIRE, 4, *to say* aux. avoir irregular	disant dit, *f.* -e	je dis tu dis il dit n. disons v. dites ils disent	je disais tu disais il disait n. disions v. disiez ils disaient	je dis tu dis il dit n. dîmes v. dîtes ils dirent	je dirai tu diras il dira n. dirons v. direz ils diront	je dirais tu dirais il dirait n. dirions v. diriez ils diraient	dis qu'il dise disons dites qu'ils disent	je dise tu dises il dise n. disions v. disiez ils disent	je disse tu disses il dît n. dissions v. dissiez ils dissent
DISCOURIR, 2, *to discourse*	discourant discouru	je discours *see* COURIR	je discourais	je discourus	je discourrai	je discourrais	discours	je discoure	je discourusse
DISPARAÎTRE, 4, *to disappear*	disparaissant disparu, *f.* -e	je disparais *see* CONNAÎTRE	je disparaissais	je disparus	je disparaîtrai	je disparaîtrais	disparais	je disparaisse	je disparusse
DISSOUDRE, 4, *to dissolve*	dissolvant dissous, *f.* -te	je dissous *see* ABSOUDRE	je dissolvais		je dissoudrai	je dissoudrais	dissous	je dissolve	
DISTRAIRE, 4, *to divert*	distrayant distrait, *f.* -e	je distrais *see* TRAIRE	je distrayais		je distrairai	je distrairais	distrais	je distraie	
DORMIR, 2, *to sleep* aux. avoir irregular	dormant dormi	je dors tu dors il dort n. dormons v. dormez ils dorment	je dormais tu dormais il dormait n. dormions v. dormiez ils dormaient	je dormis tu dormis il dormit n. dormîmes v. dormîtes ils dormirent	je dormirai tu dormiras il dormira n. dormirons v. dormirez ils dormiront	je dormirais tu dormirais il dormirait n. dormirions v. dormiriez ils dormiraient	dors qu'il dorme dormons dormez q.i. dorment	je dorme tu dormes il dorme n. dormions v. dormiez ils dorment	je dormisse tu dormisses il dormît n. dormissions v. dormissiez ils dormissent
ÉCHOIR, 3, *to fall due*	échéant échu, *f.* -e	il échoit or il échet ils échoient		il échut ils échurent	il écherra ils écherront	il écherrait ils écherraient			qu'il échût qu'ils échussent
ÉCLORE, 4, *to hatch* aux. être	éclos, *f.* -e	il éclôt ils éclosent			il éclora ils écloront	il éclorait ils écloraient		il éclose ils éclosent	
ÉCONDUIRE, 4, *to refuse*	éconduisant éconduit, *f.* -e	j'éconduis *see* CONDUIRE	j'éconduisais	j'éconduisis	j'éconduirai	j'éconduirais	éconduis	j'éconduise	j'éconduisisse
ÉCRIRE, 4, *to write* aux. avoir irregular	écrivant écrit, *f.* -e	j'écris tu écris il écrit n. écrivons v. écrivez ils écrivent	j'écrivais tu écrivais il écrivait n. écrivions v. écriviez ils écrivaient	j'écrivis tu écrivis il écrivit n. écrivîmes v. écrivîtes ils écrivirent	j'écrirai tu écriras il écrira n. écrirons v. écrirez ils écriront	j'écrirais tu écrirais il écrirait n. écririons v. écririez ils écriraient	écris qu'il écrive écrivons écrivez q.i. écrivent	j'écrive tu écrives il écrive n. écrivions v. écriviez ils écrivent	j'écrivisse tu écrivisses il écrivît n. écrivissions v. écrivissiez ils écrivissent
ÉLIRE, 4, *to elect*	élisant élu, *f.* -e	j'élis *see* LIRE	j'élisais	j'élus	j'élirai	j'élirais	élis	j'élise	j'élusse
ÉMETTRE, 1, *to emit*	émettant émis, *f.* -e	j'émets *see* METTRE	j'émettais	j'émis	j'émettrai	j'émettrais	émets	j'émette	j'émisse
EMMENER, 1, *to take away*	emmenant emmené, *f.* -e	j'emmène	j'emmenais *see* MENER	j'emmenai	j'emmènerai	j'emmènerais	emmène	j'emmène	j'emmenasse
ÉMOUDRE, 4, *to sharpen*	émoulant émoulu, *f.* -e	j'émouds *see* MOUDRE	j'émoulais	j'émoulus	j'émoudrai	j'émoudrais	émouds	j'émoule	j'émoulusse
ÉMOUVOIR, 3, *to excite, etc.*	émouvant ému, *f.* -e	j'émeus *see* MOUVOIR	j'émouvais	j'émus	j'émouvrai	j'émouvrais	émeus	j'émeuve	j'émusse
EMPLOYER, 1, *to employ*	employant employé, *f.* -e	j'emploie	j'employais *see* APPUYER	j'employai	j'emploierai	j'emploierais	emploie	j'emploie	j'employasse
EMPREINDRE, 1, *to imprint*	empreignant empreint, *f.* -e	j'empreins *see* CRAINDRE	j'empreignais	j'empreignis	j'empreindrai	j'empreindrais	empreins	j'empreigne	j'empreignisse
ENCLORE, 1, *to enclose*	enclos, *f.* -e	j'enclos tu enclos il enclôt			j'enclorai tu encloras, etc.	j'enclorais tu enclorais, etc.	enclos qu'il enclose q.i. enclosent	j'enclose tu encloses il enclose n. enclosions v. enclosiez ils enclosent	
ENCOURIR, 2, *to incur*	encourant encouru, *f.* -e	j'encours *see* COURIR	j'encourais	j'encourus	j'encourrai	j'encourrais	encours	j'encoure	j'encourusse

ENDORMIR, 2, *to lull asleep*	endormant endormi, *f.* -e	j'endors see DORMIR	j'endormais	j'endormis	j'endormirai	j'endormirais	endors	j'endorme	j'endormisse
ENDUIRE, 1, *to plaster*	enduisant enduit, *f.* -e	j'enduis see CONDUIRE	j'enduisais	j'enduisis	j'enduirai	j'enduirais	enduis	j'enduise	j'enduisisse
ENFREINDRE, 1, *to infringe*	enfreignant enfreint, *f.* -e	j'enfreins see CEINDRE	j'enfreignais	j'enfreignis	j'enfreindrai	j'enfreindrais	enfreins	j'enfreigne	j'enfreignisse
ENFUIR (s'), 2, *to run away*	s'enfuyant enfui, *f.* -e	je m'enfuis see FUIR	je m'enfuyais	je m'enfuis	je m'enfuirai	je m'enfuirais	enfuis-toi	je m'enfuie	je m'enfuisse
ENJOINDRE, 1, *to enjoin*	enjoignant enjoint, *f.* -e	j'enjoins see CEINDRE	j'enjoignais	j'enjoignis	j'enjoindrai	j'enjoindrais	enjoins	j'enjoigne	j'enjoignisse
ENNUYER (s'), 1, *to be weary*	s'ennuyant ennuyé, *f.* -e	je m'ennuie see APPUYER	je m'ennuyais	je m'ennuyai	je m'ennuierai	je m'ennuierais	ennuie-toi	je m'ennuie	je m'ennuyasse
ENQUÉRIR (s'), 2, *to inquire*	s'enquérant enquis, *f.* -e	je m'enquiers see ACQUÉRIR	je m'enquérais	je m'enquis	je m'enquerrai	je m'enquerrais	enquiers-toi	je m'enquière	je m'enquisse
ENTREMETTRE (s'), 4, *to interpose*	s'entremettant entremis, *f.* -e	je m'entremets see METTRE	je m'entremettais	je m'entremis	je m'entremettrai	je m'entremettrais	entremets-toi	je m'entremette	je m'entremisse
ENTREPRENDRE, 4, *to undertake*	entreprenant entrepris, *f.* -e	j'entreprends see PRENDRE	j'entreprenais	j'entrepris	j'entreprendrai	j'entreprendrais	entreprends	j'entreprenne	j'entreprisse
ENTRETENIR, 2, *to entertain*	entretenant entretenu, *f.* -e	j'entretiens see TENIR	j'entretenais	j'entretins	j'entretiendrai	j'entretiendrais	entretiens	j'entretienne	j'entretinsse
ENTREVOIR, 3, *to glimpse at*	entrevoyant entrevu, *f.* -e	j'entrevois see VOIR	j'entrevoyais	j'entrevis	j'entreverrai	j'entreverrais	entrevois	j'entrevoie	j'entrevisse
ENVOYER, 1, *to send* aux. avoir irregular	envoyant envoyé, *f.* -e	j'envoie tu envoies il envoie n. envoyons v. envoyez ils envoient	j'envoyais tu envoyais il envoyait n. envoyions v. envoyiez ils envoyaient	j'envoyai tu envoyas il envoya n. envoyâmes v. envoyâtes ils envoyèrent	j'enverrai tu enverras il enverra n. enverrons v. enverrez ils enverront	j'enverrais tu enverrais il enverrait n. enverrions v. enverriez ils enverraient	envoie qu'il envoie envoyons envoyez q. i. envoient	j'envoie tu envoies il envoie n. envoyions v. envoyiez ils envoient	j'envoyasse tu envoyasses il envoyât n. envoyassions v. envoyassiez i. envoyassent
ÉPRENDRE (s'), 4, *to be smitten*	s'éprenant épris, *f.* -e	je m'éprends see PRENDRE	je m'éprenais	je m'épris	je m'éprendrai	je m'éprendrais	éprends-toi	je m'éprenne	je m'éprisse
ESSAYER, 1, *to try*	essayant essayé, *f.* -e	j'essaye tu essayes il essaye *or* il essaie n. essayons v. essayez ils essayent *or* ils essaient	j'essayais	j'essayai	j'essayerai, j'essaierai, *or* j'essairai	j'essayerais j'essaierais, *or* j'essairais	essaye	j'essaye	j'essayasse
ÉTEINDRE, 4, *to extinguish*	éteignant éteint, *f.* -e	j'éteins see CEINDRE	j'éteignais	j'éteignis	j'éteindrai	j'éteindrais	éteins	j'éteigne	j'éteignisse
ÉTINCELER, 1, *to sparkle*	étincelant étincelé, *f.* -e	j'étincelle see APPELER	j'étincelais	j'étincelai	j'étincellerai	j'étincellerais	étincelle	j'étincelle	j'étincelasse
ÉTIQUETER, 1, *to label*	étiquetant étiqueté, *f.* -e	j'étiquète see ACHETER	j'étiquetais	j'étiquetai	j'étiquèterai	j'étiquèterais	étiquète	j'étiquète	j'étiquetasse
ÊTRE, 1, *to be*									
ÉTREINDRE, 4, *to press*	étreignant étreint, *f.* -e	j'étreins see CEINDRE	j'étreignais	j'étreignis	j'étreindrai	j'étreindrais	étreins	j'étreigne	j'étreignisse
EXCLURE, 4, *to exclude*	excluant exclu, *f.* -e	j'exclus see CONCLURE	j'excluais	j'exclus	j'exclurai	j'exclurais	exclus	j'exclue	j'exclusse
EXTRAIRE, 4, *to extract*	extrayant extrait, *f.* -e	j'extrais see TRAIRE	j'extrayais		j'extrairai	j'extrairais	extrais	j'extraie	
FAILLIR,* 2, *to fail* irregular	faillant failli	je faux tu faux il faut n. faillons v. faillez ils faillent	je faillais tu faillais il faillait n. faillions v. failliez ils faillaient	je faillis tu faillis il faillit n. faillîmes v. faillîtes ils faillirent	je faudrai tu faudras il faudra n. faudrons v. faudrez ils faudront	je faudrais tu faudrais il faudrait n. faudrions v. faudriez ils faudraient		je faille, etc.	je faillisse, etc.

* In the sense of *to become a bankrupt*, this verb has become regular; *faillissant, je faillis, je faillissais, je faillirai, je faillirais, que je faillisse.* (LITTRÉ.)

Infinitive.	Participles.	Indicative.				Conditional Present.	Imperative.	Subjunctive.	
		Present.	Imperfect.	Past Definite.	Future.			Present.	Imperfect.
FAIRE, 4, *to do, to make* aux. avoir irregular	faisant fait, *f.* -e	je fais tu fais il fait n. faisons v. faites ils font	je faisais tu faisais il faisait n. faisions v. faisiez ils faisaient	je fis tu fis il fit n. fîmes v. fîtes ils firent	je ferai tu feras il fera n. ferons v. ferez ils feront	je ferais tu ferais il ferait n. ferions v. feriez ils feraient	fais qu'il fasse faisons faites qu'ils fassent	je fasse tu fasses il fasse n. fassions v. fassiez ils fassent	je fisse tu fisses il fît n. fissions v. fissiez ils fissent
FALLOIR, 3, *to be necessary*, imp.	fallu	il faut	il fallait	il fallut	il faudra	il faudrait		qu'il faille	qu'il fallût
FEINDRE, 4, *to feign*	feignant feint, *f.* -e	je feins *see* CRAINDRE	je feignais	je feignis	je feindrai	je feindrais	feins	je feigne	je feignisse
FICELER, 1, *to cord*	ficelant ficelé, *f.* -e	je ficelle *see* APPELER	je ficelais	je ficelai	je ficellerai	je ficellerais	ficelle	je ficelle	je ficelasse
FRIRE, 4, *to fry* defective	frit, *f.* -e	je fris tu fris il frit			je frirai tu friras il frira, etc.	je frirais tu frirais il frirait, etc.	fris		
FUIR, 2, *to flee*	fuyant fui	je fuis tu fuis il fuit n. fuyons v. fuyez ils fuient	je fuyais tu fuyais il fuyait n. fuyions v. fuyiez ils fuyaient	je fuis tu fuis il fuit n. fuîmes v. fuîtes ils fuirent	je fuirai tu fuiras il fuira n. fuirons v. fuirez ils fuiront	je fuirais tu fuirais il fuirait n. fuirions v. fuiriez ils fuiraient	fuis qu'il fuie fuyons fuyez qu'ils fuient	je fuie tu fuies il fuie n. fuyions v. fuyiez ils fuient	je fuisse tu fuisses il fuît n. fuissions v. fuissiez ils fuissent
GELER, 1, *to freeze*, imp.	gelant gelé, *f.* -e	il gèle	il gelait	il gela	il gèlera	il gèlerait		qu'il gèle	qu'il gelât
GÉSIR, 2, *to lie* defective	gisant	il gît n. gisons v. gisez ils gisent	je gisais tu gisais il gisait n. gisions v. gisiez ils gisaient						
GRASSEYER, 1, *to lisp*	grasseyant grasseyé	je grasseye tu grasseyes il grasseye n. grasseyons v. grasseyez ils grasseyent	je grasseyais	je grassey	je grasseyerai	je grasseyerais	grasseye	je grasseye	je grasseyasse
GRÊLER, 1, *to hail*, imp.	grêlant grêlé	il grêle	il grêlait	il grêla	il grêlera	il grêlerait		qu'il grêle	qu'il grêlât
GRÉSILLER, 1, *to sleet*, imp.	grésillant grésillé	il grésille	il grésillait	il grésilla	il grésillera	il grésillerait		q. i. grésille	q. i. grésillât
HAÏR, 2, *to hate* aux. avoir irregular	haïssant haï, *f.* -e	je hais tu hais il hait n. haïssons v. haïssez ils haïssent	je haïssais tu haïssais il haïssait n. haïssions v. haïssiez ils haïssaient	je haïs tu haïs il haït n. haïmes v. haïtes ils haïrent	je haïrai tu haïras il haïra n. haïrons v. haïrez ils haïront	je haïrais tu haïrais il haïrait n. haïrions v. haïriez ils haïraient	hais qu'il haïsse haïssons haïssez q.i. haïssent	je haïsse tu haïsses il haïsse n. haïssions v. haïssiez ils haïssent	je haïsse tu haïsses il haït n. haïssions v. haïssiez ils haïssent
HARCELER, 1, *to torment*	harcelant harcelé, *f.* -e	je harcèle	je harcelais	je harcelai	je harcèlerai	je harcèlerais	harcèle	je harcèle	je harcelasse
IMPORTER, 1, *to matter* impersonal		il importe *it matters*	il importait	il importa	il importera	il importerait		q. i. importe	q. i. importât
INDUIRE, 4, *to induce*	induisant induit, *f.* -e	j'induis *see* CONDUIRE	j'induisais	j'induisis	j'induirai	j'induirais	induis	j'induise	j'induisisse
INSCRIRE, 4, *to inscribe*	inscrivant inscrit, *f.* -e	j'inscris *see* ÉCRIRE	j'inscrivais	j'inscrivis	j'inscrirai	j'inscrirais	inscris	j'inscrive	j'inscrivisse

PNEUMATICS.—IV.

[Continued from Vol. IV., p. 380.]

MEASUREMENT OF THE PRESSURE AND TEMPERATURE OF GAS AT CONSTANT VOLUME—LAW CONNECTING PRESSURE AND TEMPERATURE OF AIR, ABSOLUTE ZERO-POINT AND ABSOLUTE TEMPERATURE—DATA AND RULES TO FIND WEIGHT OF GASES—NUMERICAL EXAMPLES.

SIMPLE GENERAL LAW FOR GASES.

We may assume, then, that the law of Charles holds for air and simple gases, such as hydrogen, oxygen, etc., when heated under constant pressure.

If v stand for the volume, and p for the pressure of a quantity of gas at temperature t, what will be its volume, v_1, when the temperature and pressure are changed to t_1 and p_1 respectively?

Suppose the pressure had remained constant whilst the temperature was changed from t to t_1, then, according to the law of Charles and equation (3)—

$$\frac{v}{v_1} = \frac{273 + t}{273 + t_1};$$

but the pressures, instead of being the same, are p and p_1 respectively, and Boyle's law tells us that the volumes of the gas are inversely proportional to the pressures to which it is subjected.

Hence we have

$$\frac{v}{v_1} = \frac{273 + t}{273 + t_1} \times \frac{p_1}{p},$$

or

$$\frac{p\,v}{273 + t} = \frac{p_1\,v_1}{273 + t_1} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Now, if we know the pressure, volume, and temperature of a quantity of gas, we can calculate this quotient,—R (say), which never alters, however the pressure, volume, and temperature of the given mass of gas may alter; and therefore, knowing any two of these afterwards, the other can readily be determined.

Thus the law of Charles, combined with that of Boyle, gives this simple general law, connecting the pressure, volume, and temperature of a gas, expressed by the equation—

$$\frac{p\,v}{273 + t} = \text{R} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where p = pressure of the given mass of gas,
v = volume of the gas,
t = its temperature (Centigrade),
and R = a constant, depending on the mass, etc.

This result is perfectly consistent with Boyle's law, for we have at once from it

$$p\,v = \text{R}\,(273 + t),$$

and so long as the temperature, t, remains constant, it is clear that the expression R $(273 + t)$ does not alter, so that the product of pressure and volume, which is equal to this number, must also remain constant.

Moreover, we have in this expression of the simple general law of gases a complete answer to the question proposed at the commencement of lesson III., page 377.

In the present lesson we shall arrive at this simple general law from experimental determination of the law connecting pressure and temperature of a gas kept at constant volume.

EXAMPLE 2.—A certain mass of hydrogen gas occupies 12 cubic feet at 25° Cent., and under atmospheric pressure; find its volume at 40° Cent. under a pressure of 10 atmospheres.

Here we are given in the first instance—

p = 1 atmosphere,
v = 12 cubic feet,
t = 25° Cent.;
afterwards p_1 = 10 atmospheres,
t_1 = 40° Cent.,
and v_1 is unknown.

Putting these values in equation (4), we may first find the constant for the given quantity of gas, and knowing p_1 and t_1, the volume v_1 will then be easily found; or we may proceed at once to substitute all the given values in the equation, thus—

$$\frac{p\,v}{273 + t} = \frac{1 \times 12}{273 + 25} = \frac{10 \times v_1}{273 + 40};$$

that is,

$$\frac{12}{298} = \frac{10\,v_1}{313};$$

hence,

$$v_1 = \frac{12 \times 313}{10 \times 298},$$

and ∴ $v_1 = 1{\cdot}26$ cubic feet. *Answer.*

The reader can readily verify this answer by finding the volume of the gas at 40° Cent., supposing the pressure to be kept constantly 1 atmosphere, and then taking one-tenth of the result to allow for the change of volume when the pressure is increased from 1 to 10 atmospheres.

EXAMPLE 3.—A certain mixture of gas and air at 127° Cent. exerts a pressure of 14·8 lb. per square inch when enclosed in a vessel of 10 cubic feet capacity: what will be the temperature of this mixture when it occupies 5 cubic feet, and exerts a pressure of 44·4 lb. per square inch?

Assuming that the mixture follows the simple general law given above, the relations expressed by equations (4) and (5) hold true. In this case we are given at first—

p = 14·8 lb. per square inch, nearly 1 atmosphere,
v = 10 cubic feet,
t = 127° Cent.;
next p_1 = 44·4 lb. per square inch, nearly 3 atmospheres.
v_1 = 5 cubic feet.
and t_1 has to be calculated.

Substituting these values in equation (4), we have

$$\frac{14.8 \times 10}{273 + 127} = \frac{44.4 \times 5}{273 + t_1},$$

that is,

$$\frac{148}{400} = \frac{222}{273 + t_1},$$

hence

$$273 + t_1 = \frac{222 \times 400}{148}$$

$$= 600;$$

therefore,

$$t_1 = 600 - 273,$$

or

$$t_1 = 327^\circ \text{ Cent.} \qquad \textit{Answer.}$$

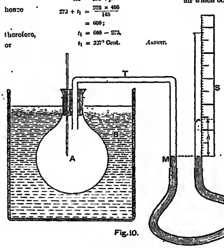


Fig. 10.

Exercise 1.—A cubic foot of gas at 20° Cent., and pressure 30 inches of mercury, is heated to 200° Cent. under the pressure 29.5 inches of mercury; what is the new volume occupied?

Answer.—1·642 cubic feet.

Exercise 2.—Find the co-efficient of expansion of air per degree Fahr. when 0° Fahr. is the starting point instead of 0° Cent.

Answer. $\frac{1}{459}$

The relation between the pressure and the temperature of air, when its volume is kept constant, may be determined by means of a simple piece of apparatus, the essential parts of which are represented by the diagram, Fig. 10.

The dry air to be experimented upon is contained in a large flask, A, immersed in the water of the bath, B. A bent piece of glass tubing, T, opens communication between the interior of the flask and the left-hand limb of the mercurial pressure-gauge to the right. This limb is connected by stout india-rubber tubing with the other arm, which consists of a glass tube that can be raised or lowered by means of a sliding-piece along a scale, S, to keep the mercury up to the mark M on the left-hand tube of the gauge; so that the enclosed air which occupies the flask A and tube T down to M is kept at constant volume. A thermometer fixed through the cork gives the temperature of the air in the flask. Special precautions are necessary to ensure that the cork remains perfectly air-tight even when the pressure of the air inside it is considerably increased. The water in the bath is heated by a Bunsen burner placed underneath it, but not shewn in the diagram.

Before making an experiment, it is necessary to note the height of the standard barometer in inches. The pressure denoted by this height, which will remain sensibly constant during the time occupied in an experiment, is in all cases to be added to the pressure indicated by the mercurial pressure-gauge, in order to ascertain the total absolute pressure on the enclosed air at any time. Next adjust the movable arm of the pressure-gauge until the top of the mercurial column in the fixed arm coincides with the datum mark, M, on the left-hand glass tube. This mark is on a level with the zero on the scale S. Note the height of the mercury in the movable glass tube, and at the same time observe the temperature of the air in the flask.

Now heat the water in the bath, B, until the thermometer shows a rise of about 2° Cent. Take away the Bunsen burner and gently stir the water in the bath B until the temperature becomes stationary; then repeat the above adjustments and observations.

Continue the heating readings as far up as is possible on the pressure-gauge; allow the water in the bath to cool *gradually*, and take, as before, simultaneous readings of the temperature and pressure of the air at constant volume. If sufficient time is not allowed for the temperature of the air to become stationary, the pressure is likely to be too low throughout the heating readings and too high during the cooling ones. For this reason the

Bunsen flame must be applied now and then whilst the water in the bath is kept well stirred; and in cooling, the flame must not be turned completely out.

In a preliminary experiment the following figures were obtained during the heating readings. The height of the standard barometer in the same room and near the apparatus was 29·8 inches, which represents the atmospheric pressure at the start. The observations may be tabulated as follows:—

Temperature of Enclosed Air, $t°$ Cent.	Difference of Levels of Mercury in Gauge Tubes; h	Total Pressure on Enclosed Air, in Inches of Mercury. $P = 29·8 + h$
23	0·83	30·63
25	1·05	30·85
28	1·35	31·15
30	1·55	31·35
33	1·85	31·65
35	2·05	31·85
38	2·40	32·20
40	2·60	32·40
43	2·85	32·65
45	3·05	32·85
48	3·40	33·20
50	3·50	33·30
53	3·85	33·65

Plot these results on squared paper, Fig. 11, having for horizontal distances the values of temperature, $t°$ Cent., and for vertical distances the corresponding values of the total pressure, or merely the difference of levels, bearing in mind that the atmospheric pressure must be added to this difference to give the total pressure of the enclosed air.

The points thus obtained are marked with little crosses, and are seen to lie fairly well along the straight line drawn amongst them, Fig. 11.

Next to deduce from this line the value of a, the co-efficient of increase in pressure of the air heated at constant volume, the fundamental law is that

$$P_1 = p_o(1 + at_1),$$

where P_1 stands for the pressure at $t_1°$ Cent.

and p_o stands for the pressure at 0° Cent.

Consequently, if P_2 stands for the pressure of same mass of air at $t_2°$ Cent. we have also

$$P_2 = p_o(1 + at_2),$$

and therefore

$$\frac{P_1}{P_2} = \frac{1 + at_1}{1 + at_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5).$$

Now, if we substitute the values of pressure and temperature from this corrected line, Fig. 11, and take a pair of observations, at say 20° and 50° Cent., we find

$$\frac{29·8 + 0·31}{29·8 + 3·55} = \frac{1 + a \times 20}{1 + a \times 50},$$

this is,

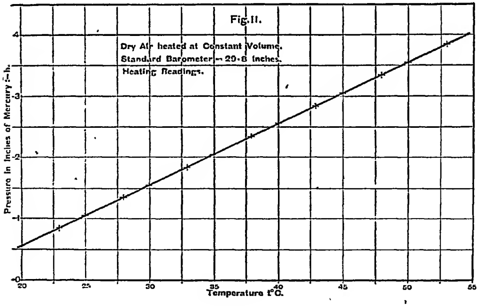
$$\frac{30·11}{33·35} = \frac{1 + 20a}{1 + 50a},$$

hence,

$$30·11 + 1505a = 33·35 + 667a$$
$$838a = 3·24,$$

and ∴

$$a = ·00381.$$



To this must be added the co-efficient of expansion of glass, ·000026, to find the absolute co-efficient of expansion for air heated under these circumstances—

$$a = \cdot 003666.$$

By heating the air through a higher range of temperature and taking cooling readings all the way down, the co-efficient obtained will be found to agree more closely with the fraction $\frac{1}{273}$, deduced from Regnault's experiments.

The following figures were obtained by Regnault for air occupying *constant volume*, and heated between 0° Cent. and 100° Cent. at pressures greater and less than atmospheric:—

Pressure at 0° Cent. in Atmospheres.	Co-efficient of Increase of Pressure, a.
0·1444	·0036482
1·0000	·0036650
4·81	·0037091

LAW CONNECTING PRESSURE AND TEMPERATURE.

Hence experiment shows that for air and many gases heated at constant volume, the pressure increases with the temperature according to the law:—

$$p_t = p_0 \left(1 + \frac{1}{273} \times t\right)$$

or

$$= p_0 \left(\frac{273 + t}{273}\right),$$

therefore,

$$\frac{p_t}{p_0} = \frac{273 + t}{273} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6).$$

where p_0 stands for the pressure at 0° Cent.
and p_t stands for the pressure at t° Cent.

In the case where $t = 273$, putting this value for t in the above equation, we find

$$p_{273} = p_0 \left(1 + \frac{1}{273} \times 273\right),$$

$$= p_0 (1 + 1),$$

$$\therefore \quad p_{273} = 2p_0;$$

in other words, at 273° Cent., the pressure of a given quantity of gas or air is double what it was at 0° Cent., the volume occupied by the gas being kept the same. That is, a quantity of air enclosed, under atmospheric pressure, in a vessel at 0° Cent., when heated to 273° Cent. will increase in elastic force and exert a pressure equal to that of two atmospheres, or $2 \times 14{\cdot}73 = 29{\cdot}46$ lb. on every square inch of surface of enclosing vessel exposed to it.

ABSOLUTE ZERO-POINT.

On the other hand, when the temperature falls whilst the volume occupied by the air remains the same, the pressure gets less.

For instance, at − 273° Cent., if the air remained in the gaseous state at constant volume and decreased in pressure at the same rate while being cooled to this extremely low temperature, its pressure would be

$$p_{-273} = p_0 \left(1 - \frac{1}{273} \times 273\right),$$

that is,

$$= p_0 (1 - 1),$$

and therefore.

$$p_{-273} = 0.$$

This means that at a temperature of 273° Cent. below the freezing-point of water, the pressure or elastic force of gas would be reduced to zero. Such a state of things might be explained by saying that the minute particles of the gas are at rest, and entirely deprived of motion, and at the same time their store of sensible heat, which usually causes them to bombard and press against the walls of the containing vessel, becomes zero. Practically, such a temperature could not easily be maintained during any appreciable time because the gas and containing vessel would receive heat from surrounding bodies, and even if it were possible by means of a freezing-machine, or the evaporation of solids at very low temperatures, to obtain such an extreme degree of cold, we know as an experimental fact that the co-efficient $\frac{1}{273}$ would not remain constant, and the gas would change its physical state to the liquid or solid at an early stage of the operation. (*See* Hydraulics I., p. 144.)

We arrive at the same important result from the fact established in the previous lesson, that the *volume of any quantity of air or other gas is directly proportional to the temperature when the pressure is kept constant*, according to the law

$$v_t = v_0 \left(1 + \frac{1}{273} \times t\right).$$

As the temperature is lowered, the air or other gas contracts and occupies smaller volume at constant pressure. Suppose this law of contraction due to fall of temperature to remain the same as at ordinary temperatures for extreme degrees of cold. If we take such a temperature that

$$t = -\frac{1}{a} = -\frac{1}{0{\cdot}00367} = -273° \text{ Cent.};$$

then the expression $1 + \frac{1}{273} \times t$ vanishes, since

$$1 + \frac{1}{273} \times (-273) = 1 - 1 = 0.$$

So that at − 273° Cent., for *any quantity* of gas kept at constant pressure, the volume vanishes, or

$$v_{-273} = v_0\left(1 - \frac{1}{273} \times 273\right) = 0.$$

This we know is contrary to reason and cannot be the case, hence we are led to infer that the law of contraction will not continue the same for very low temperatures as at the ordinary temperature, which experiment proves to be consistent with fact. We are led, therefore, to prefer the other assumption, that at this particular temperature the *pressure* of the gas would become zero, that is, the gas would cease to press against the walls of the containing vessel, with the exception of the action of gravity on the gas upon the bottom of the vessel.

This temperature, $-273°$ Cent., at which gases would be altogether deprived of heat and would exert no pressure whatever, is called the absolute zero-point, and forms the basis of an *absolute scale of temperature*. Temperatures reckoned from this absolute zero-point are called absolute temperatures. Ordinary readings on the Centigrade scale are changed into *absolute temperatures* by adding 273. Readings on the Fahrenheit scale are converted into absolute temperatures by adding to them 459·4 or about 460.

Taking the large capital letter T to stand for absolute temperature, and small italic t the temperature in Centigrade degrees, we have

$$T = t + 273.$$

This device enables us to simplify all the above formulæ; thus, the law, equation (6), connecting the pressure and temperature of a gas at constant volume, becomes

$$\frac{p}{p_0} = \frac{T}{T_0},$$

that is to say, *the pressure is directly proportional to the absolute temperature*, for any quantity of gas kept at constant volume.

We can, by this simple rule, find the temperature of air or gas by observing its pressure at constant volume, provided we are given its pressure at any other temperature.

Hence also the general law, equation (4), in the last lesson, may be written in the form

$$\frac{pv}{T} = \frac{p_1 v_1}{T_1}.$$

So that, for what is known as an ideal perfect gas which follows the laws of Boyle and of Charles, we always have the quotient

$$\frac{pv}{T} = \text{constant},$$

however the pressure, volume, and temperature may alter, whilst the amount of gas remains the same, where

p = absolute pressure above vacuum,
v = total volume occupied by the gas,
and T = absolute temperature of this perfect gas, provided this temperature is well above what Andrews called the *critical point*. (See Hydraulics I., pp. 145 and 146.)

When we express the volume in terms of the *length* of cylinder or tube of uniform bore, occupied by the gas (lesson II., Vol. IV., p. 309) this simple general law is

$$\frac{pl}{T} \text{ constant.}$$

DATA AND RULES TO FIND WEIGHT OF AIR AND GASES.

From Regnault's determinations, or by direct measurement, we find that, at 0° Cent., and under a pressure of 760 millimetres of mercury, ordinary dry air weighs 1·2932 gramme per litre—that is, ·0807 lb. per cubic foot. Under the same standard conditions, a litre of hydrogen gas weighs ·0896 gramme, or ·00559 lb. per cubic foot. With hydrogen as unit weight, the density of every gaseous compound is found to be *half* its molecular weight—that is to say, *half* the sum of the combining weights of its constituents. Hence the very simple rule:—

To find the weight of a gas in pounds per cubic foot, at 0° Cent., and standard atmospheric pressure:

Multiply half the molecular weight of the gas by 0·00559.

For example, 1 cubic foot of carbonic acid gas (CO_2) at standard pressure and 0° Cent., weighs

$$\frac{12 + 16 \times 2}{2} \times 0{\cdot}00559 = 22 \times {\cdot}00559 = {\cdot}12298 \text{ lb.}$$

A cubic foot of nitrogen gas (N_2) weighs

$$\frac{2 \times 14}{2} \times {\cdot}00559 = {\cdot}07826 \text{ lb.}$$

In the same way a cubic foot of marsh gas (CH_4) weighs

$$\frac{12 + 4}{2} \times 0{\cdot}00559 = 8 \times 0{\cdot}00559 = {\cdot}0447 \text{ lb.}$$

Similarly, *to find the weight of any gas in grammes per litre, multiply half the molecular weight of the gas by* 0·0896.

Thus a litre of nitrogen at 0° Cent. and 760 mm. pressure weighs

$$14 \times 0{\cdot}0896 = 1{\cdot}2544 \text{ gramme}$$

It is now easy to calculate the weight of any given volume of a gas when we know the temperature and pressure at which the volume was measured. We have only got to reduce the volume of the gas at the given temperature and pressure to what it would be at 0° Cent. and standard atmospheric pressure, and then multiply the volume so found by the weight of unit volume under these standard conditions.

Thus,

$$\frac{v_0}{v} = \frac{273}{273 + t}$$

$$\text{and} \quad v_0 = v \, \frac{273}{273 + t},$$

where v stands for the volume of gas at $t°$ Cent.,
and v_0 stands for the volume of gas at 0° Cent.
Further, if p be the pressure of gas at $t°$ Cent.,
and if p_0 be the pressure of same gas at 0° Cent.,
we must multiply the volume of the gas at $t°$ Cent. by p, and divide by standard pressure $p°$ to find the volume at 0° Cent.

Hence the volume of the gas reduced to 0° Cent. and 760 mm. pressure, is

$$v_0 = v \times \frac{273}{273 + t} \times \frac{p}{760}$$

The same result is obtained directly from the equation,

$$\frac{p_0 v_0}{T_0} = \frac{pv}{T},$$

thus,

$$v_0 = v \times \frac{T_0}{T} \times \frac{p}{p_0},$$

where p, v, and T, are the observed pressure, volume, and absolute temperature, and v_0 is the volume of the same amount of gas at standard pressure, and temperature, p_0 and T_0, respectively.

Example 1.—A litre of dry air at 0° Cent. and 760 mm. pressure, weighs 1·2932 grammo. Find the weight of 1,800 cubic centimetres of air at a temperature of 20° Cent., and under a pressure of 735 millimetres of mercury. By the last formula we have at once

$$\text{Required weight} = 1{\cdot}2932 \times 1{\cdot}8 \times \frac{273}{273 + 20} \times \frac{735}{760},$$

$$= 2{\cdot}098 \text{ grammes.} \qquad \textit{Answer.}$$

Example 2.—The upcast shaft of a chimney is 80 feet in height and 1·5 square feet in cross sectional area. What is the difference between the weight of the full of this shaft of air at 200° Cent., and pressure 25 inches of mercury, and the weight of a column of air of the same volume at 17° Cent., and pressure of 30 inches of mercury?

The volume of the shaft-full of air $= 80 \times 1{\cdot}5 =$ 120 cubic feet; and if we take the weight of air as ·0807 lb. per cubic foot at 17° Cent., the weight of the shaft-full is

$$W = {\cdot}0807 \times 120 \times \frac{273 + 17}{273 + 200} \times \frac{25}{30}$$

$$= 4{\cdot}948 \text{ lb.}$$

Now 120 cubic feet of cold air weighs

$$= 120 \times {\cdot}0807 = 9{\cdot}684 \text{ lb.}$$

Therefore, the difference in weight

$$= 9{\cdot}684 - 4{\cdot}948.$$
$$= 4{\cdot}736 \text{ lb.} \qquad \textit{Answer.}$$

BOOK-KEEPING.—XVII.

[Continued from Vol. IV., p. 308.]

THE fundamental principles on which Official Book-keeping proceeds being the same as for other book-keeping, and its peculiarities not being numerous, the following items, though comparatively few, will probably be found sufficiently illustrative of its more salient points.

We assume that there is a department of the Government to which is entrusted the care of public buildings, and that, in addition to looking after the buildings, it has the supervision of the furniture and fixtures contained in them. We further assume that the Vote amounts to £12,000 in all, and that it has to be accounted for under four sub-heads, viz.:

A. New Buildings	£6,000	
B. Repairs to Buildings and Maintenance	5,000	
C. Furniture	400	
D. Fuel	600	
		£12,000

1897 *April* 1.—*The Treasury announce to the Department that the House of Commons has voted £2,000 on account of Public Buildings, etc., and that this sum is available* . £2,000

Open an account for H. M. Exchequer, and debit it; open a general account for the "Vote" and credit it. It is not, at first sight, easy to see what transfer of property is involved here, but we may, perhaps, not inappropriately say that the Vote account represents the House of Commons or the Taxpayers; and that the transfer of Cash, in the shape of taxes, from the latter to the Exchequer requires us to credit the account for the House of Commons or the Taxpayers, who have voted, or paid the money, and to debit the Exchequer, who have received it.

April 2.—*The Paymaster-General (acting as banker) withdraws from the Exchequer to meet payments to be authorised by the Department* £1,500

Open an account for H. M. Paymaster-General and debit it, crediting the account for the Exchequer. These entries are in obvious accord with the fundamental rule of book-keeping by which the transferrer of cash or other property is credited, and the transferree debited.

April 9.—*Orders are issued by the Department instructing the Paymaster-General to pay certain persons certain sums amounting together to the following totals.*

A. New Buildings	£750
B. Repairs to Buildings and Maintenance	500
C. Furniture	50

Separate accounts are opened for these sub-heads, each subsidiary account standing for the General Vote account in so far as any items included under that sub-head are concerned. These subsidiary accounts representing, like the General Vote account whose place they take, the House of Commons or the Taxpayers, are debited with all expenditure disbursed on the public account, so that we must debit the account for New Buildings with £750; the account for Repairs to Buildings and Maintenance with £500, and the account for Furniture with £50; the total amount £1,300 being credited, until actually paid by the Paymaster-General, to an account entitled "Orders Payable."

April 30.—*The Paymaster-General has announced during the month that he has paid orders amounting to* £1.200

Debit Orders Payable and credit Paymaster-General.

May 31.—*The Paymaster-General has announced during the month that he has paid* . £100

Debit Orders Payable and credit Paymaster-General.

Aug. 5.—*The Treasury announce to the Department that the House of Commons has voted the balance on account of Public Buildings, and that this sum is available* . . £10,000

Debit H. M. Exchequer and credit the General account for the Vote.

Aug. 7.—*The Paymaster-General withdraws from the Exchequer* £6,000

Debit Paymaster-General and credit H. M. Exchequer.

Aug. 14.—*Orders are issued by the Department instructing the Paymaster-General to pay*

A. New Buildings - - - - - -	£3,000
B. Repairs to Buildings and Maintenance -	2,500
C. Furniture - - - - - - - -	200
D. Fuel - - - - - - - - -	400

Debit New Buildings with £3,000; Repairs, etc., with £2,500; Furniture with £200, and Fuel with £400; credit the whole £6,100 to Orders Payable.

Aug. 31.—*The Paymaster-General has announced during the month that he has paid* . £5,600

Debit Orders Payable and credit Paymaster-General.

Sept. 30.—*The Paymaster-General has announced during the month that he has paid* . £500

Again debit Orders Payable and credit Paymaster-General.

Oct. 2.—*A sale of furniture charged to a closed Vote account—i.e., the account of a former year, takes place, and a Receivable Order is issued for the receipt of this sum by the Bank of England to be placed to the credit of the Paymaster-General, to be treated by him as an Extra Receipt* £50

Debit Orders Receivable, and credit an account to be opened under the name of "Extra Receipts"

Oct. 31.—*The Paymaster-General during the month has announced the receipt of the last-mentioned sum* £50

Debit Paymaster-General, and credit Orders Receivable.

1898 *Feb.* 28.—*The Paymaster-General under instruction pays over to the Exchequer the amount standing to the credit of the 'Extra Receipts account* £50

Debit the account for Extra Receipts, which is the Exchequer's account, and credit Paymaster-General.

March 6.—*The Paymaster-General withdraws from the Exchequer the balance of the Vote* £4,500

Debit Paymaster-General, and credit Exchequer.

March 13.—*Orders are issued by the Department instructing the Paymaster-General to pay certain persons certain sums amounting to*

A. New Buildings - - - - -	£2,020 : – : –
B. Repairs, etc. - - - - -	1,995 . 10 : –
C. Furniture - - - - - -	151 : 16 . 6
D Fuel - - - - - -	398 . 5 : –

Debit New Buildings with £2.020, Repairs, etc., with £1,995 10s., Furniture with £151 16s. 6d, and Fuel with £398 5s ; and credit the total amount, £4,565 11s. 6d., to Orders Payable.

March 31.—*The Paymaster-General has announced during the month that he has paid orders amounting to* . . . £4,725 : – : 6

Debit Orders Payable and credit Paymaster-General.

March 31 (*or later*).—*The balances on the subsidiary accounts for the Vote are now to be transferred to the General account for the Vote.* In this way each subsidiary account is closed. The General account having been thus dealt with, shows in a concise form the balance of the total Vote remaining unexpended, while the remaining accounts in the Ledger, in the present case merely the Paymaster-General's and the account for Orders Payable, show where—*i.e.*, between what assets and liabilities—that balance is to be found.

About March of the following year (1899), the account of the Vote, as now given in the Ledger, having been meanwhile audited and submitted with the Auditor-General's Report to the Public Accounts Committee of the House of Commons, and

by them approved, the balance of £34 : 8 : 6 is paid back to the Exchequer, and the accounts for the Vote closed. This transaction involves a debit to the Vote account, and a credit to the Exchequer; also a debit to the Exchequer, and a credit to the Paymaster-General. By means of this fourfold entry the whole of the transactions with the Exchequer are shown in that account. The £34 : 8 : 6 is conveniently left as a balance on the Vote account until the account has passed the Public Accounts Committee of the House of Commons. It can hardly be said to be due to the Exchequer before; besides, some alteration may be directed to be made by that Committee, and this would have to be shown by a supplementary entry in the Vote account.

VOTE FOR PUBLIC BUILDINGS, 1897-98.

		£	s.	d.			£	s.	d.
1897.					1897.				
Mar. 31	To New Buildings	5,770	–	–	Ap. 30	By Exchequer	2,000	–	–
„ „	„ Repairs, etc	4,995	10	–	Aug. 31	„ do	10,000	–	–
„ „	„ Furniture	401	16	6					
„ „	„ Fuel	798	5	–					
„ „	„ Balance, carried down	34	8	6					
		12,000	–	–			12,000	–	–
					1898.				
					Ap. 1	By Balance, brought down (pending adoption by the H. of C.)	34	8	6

H.M. EXCHEQUER.

		£	s.	d.			£	s.	d.
1897.					1897.				
Ap. 30	To Vote	2,000	–	–	Ap. 30	By Paymaster-General	1,500	–	–
Aug. 31	„ do.	10,000	–	–	Aug. 31	„ do.	6,000	–	–
					1898.				
					Mar. 31	„ do.	4,500	–	–
		12,000	–	–			12,000	–	–

PAYMASTER-GENERAL.

		£	s.	d.			£	s.	d.
1897					1897.				
Ap. 30	To Exchequer	1,500	–	–	Ap. 30	By Orders Payable	1,200	–	–
Aug 31	„ do.	6,000	–	–	May 31	„ do.	100	–	–
Oct. 31	„ Orders Receivable	50	–	–	Aug. 31	„ do.	5,600	–	–
1898.					Sept. 30	„ do	500	–	–
Mar 31	„ Exchequer	4,500	–	–	1898.				
„ „	„ Balance, carried down	125	–	6	Feb. 28	„ Extra Receipts	50	–	–
					Mar. 31	„ Orders Payable	4,725	–	6
		12,175	–	6			12,175	–	6
					Ap. 1	By Balance, brought down	125	–	6

ORDERS RECEIVABLE.

		£	s.	d.			£	s.	d.
1897.					1897.				
Oct. 31	To Extra Receipts	50	–	–	Oct. 31	By Paymaster-General	50	–	–

ORDERS PAYABLE.

		£	s.	d.			£	s.	d.
1897.					1897.				
Ap. 30	To Paymaster-General	1,200	–	–	Ap. 30	By Sundries	1,300	–	–
May 31	" do.	100	–	–	Aug. 31	" do.	6,100	–	–
Aug. 31	" do.	5,600	–	–	1898.				
Sept. 30	" do.	500	–	–	Mar. 31	" do.	4,565	11	6
1898					" "	" Balance, carried down	159	9	–
Mar. 31	" do.	4,725	–	6					
		12,125	–	6			12,125	–	6
Ap. 1	To Balance, brought down	159	9	–					

NEW BUILDINGS.

		£	s.	d.			£	s.	d.
1897.					1898.				
Ap. 30	To Orders Payable	750	–	–	Mar. 31	By Vote (Bal. to Vote a/c)	5,770	–	–
Aug. 31	" do.	3,000	–	–					
1898.									
Mar 31	" do.	2,020	–	–					
		5,770	–	–			5,770	–	–

REPAIRS, ETC.

		£	s.	d.			£	s.	d.
1897.					1898.				
Ap. 30	To Orders Payable	500	–	–	Mar. 31	By Vote (Bal. to Vote a/c)	4,995	10	–
Aug 31	" do.	2,500	–	–					
1898.									
Mar. 31	" do.	1,995	10	–					
		4,995	10	–			4,995	10	–

FURNITURE.

		£	s.	d.			£	s.	d.
1897.					1898.				
Ap. 30	To Orders Payable	50	–	–	Mar. 31	By Vote (Bal. to Vote a/c)	401	10	6
Aug 31	" do.	200	–	–					
1898.									
Mar. 31	" do.	151	10	6					
		401	10	6			401	10	6

FUEL.

		£	s.	d.			£	s.	d.
1897.					1898.				
Aug. 31	To Orders Payable	400	–	–	Mar. 31	By Vote (Bal. to Vote a/c)	798	5	–
1898									
Mar 31	" do.	398	5	–					
		798	5	–			798	5	–

EXTRA RECEIPTS.

		£	s.	d.			£	s.	d.
1898.					1897.				
Feb. 28	To Paymaster-General	50	–	–	Oct. 31	By Orders Receivable	50	–	–

GEOMETRICAL PERSPECTIVE.—X.

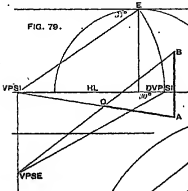
[Continued from Vol. IV., p. 365.]

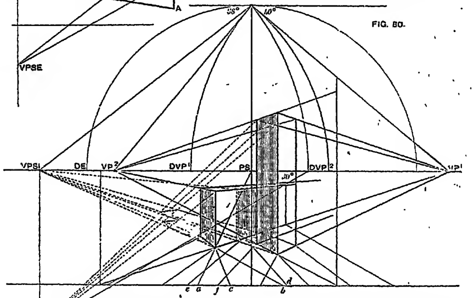
PROBLEMS—XLIX—LI.

PERSPECTIVE OF SHADOWS.

We now propose to consider the projection of shadows as they appear under the *second* condition mentioned in the previous lesson (Vol. IV., p. 362): viz., *when the sun is before, or in front of the picture; that is, when it is behind the spectator, or when the spectator is between the sun and the object.*

FIG. 79.





Rule.—Draw a line from the station point, or E, to the horizontal line at the *same angle with the picture plane* at which the *horizontal direction* of the shadow is said to be inclined; this will give the VP for the sun's inclination. The *length* of the shadow is determined according to the sun's elevation (or height in the heavens). *Therefore the angle of elevation must be constructed by drawing a line, at the given angle of elevation, from the distance point of the vanishing point of the sun's inclination* to meet the perpendicular line drawn through the VP of the sun's inclination. This will be the VP for the sun's elevation, and will be the point of direction to determine the lengths of the shadows, by drawing to it lines from the angles and projecting parts of the object, to cut those drawn from the object in the direction of the VP for the sun's inclination. When the position of the sun is, as in the present case, before the picture, the line forming the angle of the sun's elevation is drawn downwards. When the sun is behind the picture, the line of the angle is drawn upwards; this latter case will be treated upon in a future lesson. To render the above rule as clear as possible, we have introduced a very simple example (Fig. 79), giving only the vanishing points for the representation of the shadow. Let AB be a pole in a perpendicular position, VPSI is the vanishing point for the sun's inclination at an angle of 35°, and VPSE, the vanishing point for the sun's elevation, is at an angle of 30° with the horizon; therefore the shadow of the pole on the ground retires towards its vanishing point on the HL, and its length is determined by a line drawn from the top of the pole towards the vanishing point of the sun's elevation, producing AC, the shadow of AB. Our pupils will perceive that the principles of the perspective of shadows closely resemble those which belong to horizontal and inclined planes.

PROBLEM XLIX. (Fig. 80).—*A rectangular block of stone 2 feet wide, 6 feet long, and 3 feet high, is lying horizontally on its narrowest side; its face is at an angle of 40° with the* PP, *3 feet within, and 2 feet to the left of the eye. Parallel to it is a long beam standing on its end, and opposite a point 2 feet from the nearest end of the block. The beam is 1 foot 6 inches square at the base, 8 feet high, and 1 foot space between the block and the beam. Sun's inclination 38°, elevation 30°, vanishing point of the sun to the left of the eye. Line of sight 5 feet. Distance from the* PP *6 feet.*

Trusting our pupils will be able to represent the perspective of the solids, we shall limit our instructions for that part of the drawing to merely reminding them of some of the leading particulars in the process of construction. *a* is 2 feet to the left of the eye, *b* is 3 feet from *a*, for the purpose of finding the nearest angle of the block within the picture by drawing from *b* to DE. To find the point in the block to which the beam is opposite, rule a line from the near angle of the block to the BP at *c*; make *c d* equal to 2 feet, and rule from *d* back again to the base of the block, directed by DVP[1]—this is cutting off from the near angle of the block a distance of 2 feet on the line of its base; rule from the point thus found towards the PP, directed by DVP[2]; upon the last line a portion of 1 foot must be cut off to obtain the perspective distance between the block and the beam, this will be between *e* and *f*. The lines for the production of the shadows are dotted, drawn from the projecting angles of the solids to the vanishing point of the sun's elevation (VPSE) to cut the lines drawn from the plans or bases of the projecting angles towards the vanishing point for the sun's inclination (VPSI). The intersection of these lines will limit the extent of the shadows, as shown in Fig. 79.

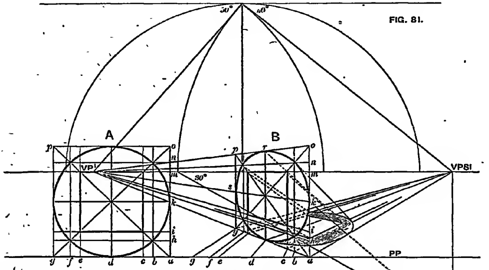


FIG. 81.

PROBLEM L. (Fig. 81).—*A circular board in a perpendicular position, 6 feet diameter, and having a square opening in the centre 3 feet wide. The plane of the board is at an angle of 50° with the picture plane. Sun's elevation 30°, and inclination 40°. Height of the eye, 4 feet 6 inches; other conditions at pleasure.*

After drawing the HL, and determining the station point, vanishing points, and distance points, the plan of the circle (A) must be made with the additional working lines for the purpose of obtaining the true form of the circle when placed in a retiring and perpendicular position B. (*See* Fig. 31, p. 345, Vol. III.; Fig. 36, p. 31, and Fig. 40, p. 33, Vol. IV.) It will then appear as a circle in a square. If the pupil will turn back to the above figures, he will at once understand why the points in the base of the plan A, viz., *a*, *b*, *c*, *d*, etc., are again set off on the PP, and the points *h*, *i*, *k*, etc., are repeated on the line of contact from *a* to *o* in Fig. B, the former for cutting off the perspective distances on the base of the retiring plane from *a* to VP[1], and the latter for

determining the perspective heights upon the same plane, their retiring lines being ruled towards the vanishing point of the plane. Thus will be reconstructed in its perspective proportions the working lines forming the square *a g p o*, and the square opening in the centre of the board. The circle representing the board must be drawn by hand through the points in the retiring plane B, which are found to correspond with the points in the plan A. To determine the extent of the shadow, lines are drawn to the vanishing point of the sun's inclination (VPSI) from all the points in the base of the retiring square *a g p o*, which contains the perspective view of the circular board. The rays of the sun's elevation are drawn from the intersections of the circle with the diagonals, and the sides of the square *a g p o* in *k s r d*. Through the points on the ground where the lines or rays for the sun's elevation intersect those which represent the sun's inclination drawn from the base of the square to VPSI, the extent and form of the shadow must be drawn; the same method of proceeding must be observed with regard to the square opening in the circular board.

PROBLEM LI. (Fig. 82).—*To show how a shadow of a perpendicular object is to be projected on an inclined plane.* Our example is the shadow of a chimney upon a roof. After the perspective view of the roof and chimney is drawn, and the vanishing points for the sun's inclination and elevation are found, draw a line from VP^2 through VP^3 (the VP for the inclination of the roof) to the perpendicular line from VPSI; this gives the VP for the shadow of the chimney on the roof, viz., VP^4, to which the lines from the base of the chimney must be drawn. For the VP of the shadow of the retiring side, *a b*, of the chimney, rule a line from VPSE through VP^1 to VP^5, the vanishing point required. We trust the figure will explain the rest.

FIG. 82.

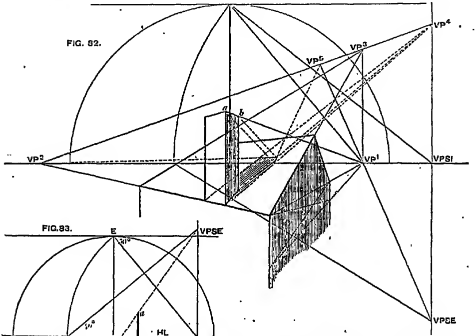


FIG. 83.

We will now give some examples of the third position of the sun, that is, when the sun is behind the picture, or in other words, when the object upon which the light falls is between the sun and the spectator.

We have said before that, when the sun is behind the picture, the vanishing line for the sun's

elevation is *inclined upwards*, determining the VP for the sun's elevation *over* the VP for the sun's inclination. To assist in explaining this, we will again make use of a line to represent a pole.

Let *a b* (Fig. 83) represent a pole. VPSI is the vanishing point of the sun's inclination at an angle of 50°; DVPSI is its distance point, from which is drawn the vanishing line at an angle of 40° with the horizon to VPSE, the vanishing point of the sun's elevation. Draw a line through *a* directed from VPSE until it cuts another line drawn through *b* directed from VPSI: these lines intersecting at *c* will give the extent and position of the shadow *c b*.

GERMAN.—XXV.

[*Continued from Vol. IV., p. 376.*]

IDIOMS OF VERBS.

Kosten, when used transitively, signifies "to test" *or* "try by tasting," as:—Er kostet den Wein, he tastes the wine.

Versuchen has sometimes the same signification, as:—Er versucht den Wein, he tries the wine (that is, by tasting).

Schmecken (to relish) denotes properly the impression made by tasting, as:—Der Wein schmeckt gut, the wine tastes good: Es schmeckt mir nicht (it does not relish to me), I do not relish it: Die Speise schmeckt nach Rauch, the food tastes of smoke (is smoky).

EXAMPLES.

Die That ist geschehen, und alle Reich'thümer der Erde können sie nicht un'geschehen machen.	The deed has transpired, and all the riches of the earth cannot make it otherwise.
Der Träge weiß nicht, was er thun soll um sich die Lange'weile zu vertrei'ben.	The slothful (man) knows not what to do in order to drive away (the) tediousness.
Dieser Rin'derbraten schmeckt mir besser, als jenes Geflü'gel.	This roast beef relishes (to me) better than that poultry.
Es war der Papagei', der soeben gesprech'en hat.	It was the parrot that just spoke.
Der Jüngling fühlte sich über den Verdacht', den man auf ihn hatte, tief gekränkt'.	The youth felt (himself) deeply mortified on account of the suspicion which rested upon him.

VOCABULARY.

Ändern, to alter, change.
Bitter, bitter.
Empfan'gen, to receive.
Gemüse, *n.* vegetables.
Jetzig, present.
Ker'kermeister, *m.* jailer.
Kuchen, *m.* cake.
Los'geben, to set free, release.
Miß'brauchen, to misuse.
Selig, blissful, blessed, happy.
Stellung, *f.* situation.
Verschaff'en, to procure.
Wunder, *n.* wonder, miracle, prodigy.
Züch'tigung, *f.* chastisement, correction.

EXERCISE 156.

Translate into English:—

1. Das Unglück ist geschehen, und nicht mehr zu ändern. 2. Wann ist ihm dieses Unglück begegnet? 3. Es geschah vor einer Stunde. 4. Was geschehen kann, soll geschehen, um diesen Leuten eine bessere Stellung zu verschaffen. 5. Es ist schon oft der Fall gewesen, daß das Vertrauen gemißbraucht worden ist. 6. Es fanden in früherer Zeit mehr Wunder und Zeichen Statt, als in der jetzigen. 7. Es geschah ihm recht, einmal eine Züchtigung empfangen zu haben. 8. Es geschieht nichts ohne Gottes Wissen und Willen. 9. Der Müßiggänger weiß nicht, was er thun soll. 10. Der fleißige Knabe wußte nicht, was er weiter thun sollte. 11. Der Kerkermeister fragte, was er thun sollte, um selig zu werden 12. Wie schmeckt Ihnen das Gemüse? 13. Es schmeckt mir vortrefflich. 14. Schmeckt Ihnen dieser Kuchen nicht? 15. O ja, er schmeckt mir sehr gut. 16. Schmeckt Ihnen das Essen? 17. Nein, Herr Doctor, es schmeckt mir Alles bitter. 18. Ich bin es der dies spricht und gesprochen hat 19. Er ist es, der diese Worte zu sprechen wagte. 20. Nicht wahr, Sie sind es, der gesagt hat, man möge die Gefangenen losgeben?

EXERCISE 157.

Translate into German:—

1. When did your friend meet with an accident? 2. It happened yesterday; he knows not how to get over it. 3. We will try everything to better his situation? 4. If the circumstances of those people were to be changed, everything would go well with them. 5. It has often been the case that his goodness has been abused. 6. The punishment which those idle boys received was right. 7. Happen what will, I shall trust in God. 8. What is done cannot be undone, and what has been said cannot be unsaid. 9. Do you relish your food? 10. No, doctor, I relish nothing; everything tastes bitter. 11. It was my friend who spoke these words; they might assist these poor emigrants. 12. What did your new carriage cost (you)? 13. It cost (me) fifty guineas. 14. Have you already tasted this cake? 15. Yes, I have, but I do not like it; have you any other?

MORE IDIOMS OF VERBS.

Versetzen (from ver, against, etc., and setzen) has a variety of significations: as, "to put in a wrong place," "to misplace," "to remove," "to pawn"; also, "to set against"—*i.e.*, "to fetch," "deal out,"

or "give," as a blow, etc. It likewise signifies "to reply," as:—Auf diese Fragen und Beschuldigungen versetzte er Folgendes, to these questions and accusations he replied as follows (following); Er versetzte dem Pferde einen Schlag, he gave the horse a blow; Der Glaube versetzt Berge, faith removes mountains.

Über Feld-gehen (*lit.*, to go over the field) signifies "to take a trip across the fields," as:—Wir gehen morgen früh über Feld, we are going to take a trip across the fields to-morrow morning.

Daß (that) is sometimes used instead of seit, and may then be translated "since," as:—Ist es lange, daß Sie ihn gesehen haben? is it long *since* you have seen him?

EXAMPLES.

Der Vater geht diesen Nachmittag über Feld.	The father goes this afternoon over the country.
Er weiß nicht, wie er zu diesem Re'genschirm gekom'men ist.	He does not know how he came by this umbrella.
Er geht beina'he alle Tage auf's Land, und erfrischt' sich an Milch und Obst.	He goes nearly every day into the country, and refreshes himself with milk and fruit.
Das Verbrech'en dieses Mannes ist an den Tag gekom'men.	The crime of this man has come to light.
Er ist lange nicht bei uns gewe'sen.	He has not for a long time been at our house.
Er ist nicht lange bei uns gewe'sen.	He has not been long at our house.

VOCABULARY.

Aus'bitten, to beg for, ask for, request.
Besé'hen, to look on *or* at, to view.
Dazu', thereto, to it.
Dürf'tigkeit, *f.* necessity, indigence.
Einfach, simple, plain.
Fangen, to take, seize.
Flach, flat, even.
Flüchtling, *m.* fugitive.
Fülle, *f.* fulness, plenty.
Goldstück, *n.* gold-piece.
Hierauf, hereupon.
Mangel, *m.* want, lack, deficiency.
Poli'tisch, political.
Post'meister, *m.* postmaster.
Schlicht, plain, homely.
Spötteln, to jeer, jibe, banter.
Städter, *m.* townsman, citizen.
Treiben, to drive.
Verrätherei', *f.* treachery.
Vor'mittag, *m.* forenoon.
Welttheil, *m.* part of the world *or* globe.
Worü'ber, of what, whereof, whereat.

EXERCISE 158.

Translate into English:—

1. Er versetzte ihm einen Schlag in das Gesicht. 2. Scherzweise versetzte mir die Schwester einen Schlag mit der flachen Hand. 3. Es schickt sich nicht für Knaben einander zu schlagen. 4. Der Vater ist über Land gegangen, und wird erst gegen Abend zurückkommen. 5. Mein Bruder war diesen Vormittag auf dem Felde, um das Korn zu besehen, und diesen Nachmittag geht er in die Stadt, um seinen kranken Vetter zu besuchen. 6. Wie sind Sie zu diesem Goldstücke gekommen? 7. Ich habe es gefunden, als ich auf das Feld ging. 8. Man weiß nicht, wie dieser Mann zu seinem Reichthume gekommen ist. 9. Reiche Leute wohnen den Winter über in der Stadt, und den Sommer auf dem Lande. 10. Wenn reiche und stolze Städter auf das Land kommen, so spötteln sie gern über die schlichten und einfachen Sitten seiner Bewohner. 11. Ludwig XVI. wurde noch an den Grenzen Frankreichs durch die Verrätherei eines Postmeisters gefangen genommen. 12. Der Dieb wurde vom Nachtwächter gefangen genommen, als er aus dem Hause entfliehen wollte. 13. Man wußte lange nicht, wer die Fremden waren, bis es endlich an den Tag kam, daß es politische Flüchtlinge waren. 14. Endlich ist es an den Tag gekommen, worüber Jahre lang der Schleier des Geheimnisses hing. 15. Ehe er sich zu mir in den Wagen setzte, bat er sich als Bedingung aus, daß ich langsam fahren möchte. 16. Als er gefragt wurde, warum er diese entwürdigende Handlung begangen habe, versetzte er, daß ihn die Noth dazu getrieben habe. 17. Hierauf versetzte ich ihm, daß Mangel kein Grund zum Diebstahl, und Noth kein Grund zu einem Verbrechen sei. 18. Das Schicksal versetzte ihn aus der Fülle in die größte Dürftigkeit, wie es mich oft aus einer Stellung in die andere, aus einem Lande in das andere und aus einem Welttheil in den andern versetzte; aber den härtesten Schlag versetzte es mir dadurch, daß es mir an dem Tage meiner Ankunft in Amerika den Bruder sterben ließ.

EXERCISE 159.

Translate into German:—

1. My brother goes to-morrow morning with his friend over the country, and will return in the evening. 2. How came you by this book? 3. As I went over the country I found it. 4. The father gave the boy a blow with his hand. 5. Upon the questions which the judge asked the criminal, he replied that he had not committed the crime purposely. 6. I have not been for a long time in Germany. 7. I have not been long in Germany. 8. It is a long time since I have seen my parents and brothers. 9. He did not know for a long time who it was that had taken his pencil-case, after it was found. 10. Let us take a pedestrian tour, as we have beautiful weather to-day. 11. How long is it since you have heard anything of your friends? 12. I do not know; but I believe it is more than a month since I have heard anything of them.

Hin, Einen Schritt thun, ETC.

Hin, applied to time, may refer as well to the future as to the past, as:—Bis zu dem zwanzigsten

Jahrhundert hin können noch viele Umwälzungen, in der alten Welt sowohl, wie in der neuen, Statt finden, up to (between this and) the twentieth century (thither) in the Old World, as well as in the New, many revolutions may yet take place; Mancher klagt nach einem leichtsinnig verlebten Jünglingsalter, daß nun die günstigste Zeit, um Kenntnisse zu erwerben, hin sei, many a one complains, after a frivolously spent youth, that (now) the most favourable period for acquiring knowledge is past (lost *or* gone). In this latter sense, dahin is likewise employed, as:—Die Ernte ist vergangen, der Sommer ist dahin, the harvest is gone, the summer is past.

Einen Schritt thun = "to take a step," as:—Welche Schritte müssen gethan werden? what steps must be taken? Schritt halten = "to keep step," "to keep pace," as:—Dieser Knabe versucht mit dem Vater gleichen Schritt zu halten, this boy tries to keep step with his father; Heinrich ist nicht fleißig genug, um beim Erlernen der deutschen Sprache mit Ernst gleichen Schritt halten zu können, Henry is not diligent enough to enable him to keep pace with Ernest in learning the German language.

Einen Schuß thun = "to make a shot," "to shoot," as:—Bis zu diesem Tage hat kein Mensch einen so berühmten Schuß gethan, wie Wilhelm Tell, up to this day has no man made so renowned a shot as William Tell.

EXAMPLES.

Wir lieben einen Menschen nicht länger, als wir ihn achten; ist die Achtung hin, so ist es auch die Liebe.	We love a man no longer than we respect him: if (the) respect is gone, so also is (the) love.
Wer einmal den ersten Schritt zu einem Verbrech'en gethan' hat, thut auch leicht den zweiten.	He who has taken the first step to a crime, also easily takes the second.
Er hat einen guten Schuß gethan'.	He has made a good shot.
Er ist so'eben an dem Fenster vorü'ber or vorbei' gegan'gen.	He has just passed by the window.
Er will nicht aus'gehen weil der Wind so stark weht.	He will not go out, because the wind blows so hard (strong).
Wir werden wohl noch Schnee bekom'men.	We shall probably yet have (get) snow.
Es geht ein starker Wind.	There is a strong wind blowing.
Von wem ist die Rede?	Of whom do you talk (is the question)?

VOCABULARY.

Auftrag, *m.* order, direction.
Binnen, within.
Erfrie'ren, to freeze, chill.
Gnädig, gracious, clement.
Hader, *m.* quarrel, brawl.
Legen, to lay (sich legen, to abate).
Pünktlich, punctual, punctually.
Schuß, *m.* shot.
Schwertstreich, *m.* stroke with the sword.
Überge'ben, to surrender, deliver.
Verfeh'len, to miss, fail.
Verscheu'chen, to scare, frighten.
Versor'ger, *m.* provider, sustainer.
Vorbei'gehen, to pass one (unnoticed), to miss the way.
Vorü'bergehen, to pass by.
Wehen, to blow.
Wilddieb, *m.* poacher, deer-stealer.

EXERCISE 160.

Translate into English:—

1. Die beiden Freunde waren es müde, länger mit einander zu streiten. 2. Der König und die Kaiserin, des langen Haders müde, sie machten endlich Friede (Bürger). 3. Da der Wind ziemlich stark und anhaltend wehte, so erblickten wir schon nach vierzehn Tagen Land. 4. Es weht heute ein sehr kalter Wind, und ich befürchte, daß wir Schnee bekommen werden. 5. Der Wind hat sich seit Mittag sehr gelegt; er weht bei weitem nicht mehr so stark, als diesen Morgen. 6. Es ging eine so kalte und schneidende Luft, daß er sich binnen fünf Minuten beide Hände erfror. 7. Lebt mein Vater noch? 8. Ja, er lebt noch, aber unser junger Freund ist nicht mehr. 9. Wohl ihm, er ist hingegangen, wo kein Schnee mehr ist. 10. Er, der Versorger so vieler Armen ist nicht mehr. 11. Wovon lebt diese arme Familie? 12. Wovon wird gesprochen? 13. Von wem spricht man? 14. Das ist etwas, wovon Sie nichts verstehen. 15. Wovon ist die Rede? 16. Von wem haben Sie das gehört? 17. Von wem hast du dieses artige Geschenk erhalten? 18. Der Wilddieb schoß nach dem Jäger, allein die Kugel verfehlte ihr Ziel, und, ehe er noch einen andern Schuß thun konnte, sank er selbst, getroffen von dem Blei des Jägers. 19. Ohne Schuß und Schwertstreich wurde die Festung übergeben. 20. Er that einige Schüsse in dem Garten, um die Vögel zu verscheuchen

EXERCISE 161.

Translate into German:—

1. You will keep pace with your brother if you are more industrious. 2. Go step by step, and thou wilt not miss thy aim. 3. From whom have you received this present? 4. Of what is it made? 5. By whom is it made? 6. Is my mother still alive? 7. Yes, she is still alive; but my father is no more. 8. Peace to him! he is gone where troubles are no more. 9. It blows very roughly to-day, and therefore it is better to stay at home. 10. I think we shall have rain when the wind abates. 11. Do not go out, for the air is so very cutting, and I fear you may chill your hands. 12. As long as the wind is in the east, it will remain cold and dry. 13. Finally, tired of the long quarrel, I made peace with my friends.

Auftragen, Anrichten, ETC.

The phrase "a friend of mine," "a friend of his," etc., is rendered in German by Ein Freund von mir (a friend of me) *or* Einer meiner Freunde (one of my friends), etc., as:—Ein Freund von ihm segelte gestern nach Californien, a friend of his sailed yesterday for California; Einer meiner Freunde verheirathete sich vor einem Vierteljahre in Amerika, a friend of mine got married three months ago in America.

Auftragen, with the accusative, signifies "to put on" (as colours), *or* "serve up" (as food), as:—Man hat die Suppe aufgetragen, they have served up the soup. With the dative, it means "to commission," "enjoin," "instruct," etc., as:—Er hat mir aufgetragen, Ihnen zu sagen, daß er Sie morgen erwartet, he has instructed me to say that he awaits (*or* expects) you to-morrow.

Anrichten (*lit.*, "to make right," or "ready for") signifies "to get in readiness," "to prepare" (as victuals); so, Unheil anrichten, "to prepare," "produce," "do mischief," as:—Nachdem die Köchin die Speisen angerichtet hatte, trug sie dieselben auf, after the cook had prepared the food, she served it up: Der Geiz hat schon viel Unheil angerichtet, avarice has already produced much mischief.

Hinreichen, when transitive, signifies "to hand," "to pass," as:—Er reichte dem Freunde das Buch hin, he handed (reached) his friend the book. When intransitive, it means "to suffice," "to be sufficient," as:—Sehr wenig reicht hin, einen klugen Menschen glücklich zu machen, very little is sufficient to make a wise man happy.

EXAMPLES.

Einer seiner Freunde wurde in Baden erschos'sen.	A friend of his was shot in Baden.
Man hat mir die Untersu'chung dieser Sache auf'getragen.	They have enjoined on me the investigation of this matter.
Man trug auf, was Küche und Keller vermoch'te.	They served up what kitchen and cellar afforded.
Der Zorn richtet nur Böses an.	Anger produces only mischief.
Es ist in Deutschland wohl'feiler leben, als in Ame'rika.	It is cheaper living in Germany than in America.
Es genügt' mir nicht, ihn zu sehen, ich will ihn auch sprechen.	It does not satisfy (suffice) me to see him; I wish to speak to him also.
Ich will es ihm hin'reichen.	I will reach it (forth) to him.
Ich wollte ihn bezah'len, aber das Geld reichte nicht hin.	I was going to pay him, but the money did not hold out (suffice).
Er ar'beitet mit großem Fleiße (sehr fleißig).	He labours with great industry (very industriously).
Er hat es mit Fleiß gethan'.	He has done it (with intention) intentionally.

VOCABULARY.

Bestre'ben, to endeavour, strive, exert oneself.
Despo'tisch, despotic, despotical.
Donau, *f.* Danube.
Erdul'den, to suffer, endure, bear.
Ertrin'ken, to drown.
Grüßen, to greet, salute.
Suppe, *f.* soup.
Va'terlandsfreund, *m.* patriot, friend of one's country.
Versu'chen, to try, taste.
Verwir'rung, *f.* perplexity, confusion.

EXERCISE 162.

Translate into English:—

1. Ein Vaterlandsfreund stirbt lieber, als daß er zum Verräther wird. 2. Die ersten Christen erduldeten lieber die härtesten Verfolgungen, als daß sie ihren Glauben verließen. 3. So etwas läßt man sich nicht zweimal sagen. 4. Einen meiner Brüder habe ich in drei Jahren nicht gesehen. 5. Ein Freund von mir ist vor einigen Jahren bei Wien in der Donau ertrunken. 6. Es ist gut reisen, wenn man Geld, und gut leben, wenn man keine Sorgen hat. 7. In einem freien Lande ist besser leben, als in einem despotischen. 8. In Begleitung munterer Freunde ist es angenehm zu reisen. 9. Nur zu leicht vergißt der Mensch im Glücke, was er ist. 10. Viele ausgezeichnete und edle Männer sind vergessen worden. 11. Es darf dem Menschen nicht genügen, zu wissen was recht ist, sondern er muß sich auch bestreben, recht zu thun. 12. Es genügt mir, zu wissen, daß Ihr noch alle gesund seid. 13. Wie weniges reicht oft hin, einen Menschen glücklich zu machen. 14. Er reichte ihm die Zeitung hin, nachdem er sie selbst gelesen hatte. 15. Dieses reichte hin, ihn zufrieden zu stellen. 16. Der Koch richtet die Speisen an. 17. Er hat diese kleine Verwirrung mit Fleiß angerichtet. 18. Die Köchin kostete die Suppe, ehe sie dieselbe auftrug. 19. Man muß versuchen, ob man ihm nicht noch helfen kann. 20. Versuchen Sie einmal diesen Wein, ob er süß genug ist. 21. Er trug mir auf, Sie von ihm zu grüßen.

EXERCISE 163.

Translate into German:—

1. I have just seen a brother of yours who has returned from India. 2. A friend of mine got married last week. 3. The teacher has enjoined on me the explanation of this subject. 4. Has my father instructed you to invite your brother to us this evening? 5. No, sir, but he instructed me to tell my father that he might call on him to-morrow morning. 6. The scholar, upon the request of the teacher, handed the book to him. 7. Riches do not suffice to make a man happy. 8. A true Christian, rather than betray his belief, endures

great suffering. 9. Is the dinner already put on the table? 10. No, sir, it is not served up; it is not yet ready. 11. It is not sufficient for a prudent man to know what is right, but he also acts rightly.

Genießen, Auf, ETC.

Genießen (to *enjoy*) governs, as already seen, the genitive or accusative. It also signifies "to take nourishment," "to eat or drink," in which use it governs the accusative only, as:—Ich habe heute wenig genossen, I have eaten but little to-day.

Auf frequently has the force of an adjective, as:—Die Thür ist auf, the door is open, *or* Die Thür ist offen. Zu is similarly used, as:—Die Thür ist zu, the door is to (closed). In this use, they are frequently compounded with verbs, especially with machen, as:—Er hat das Fenster auf-, und sie hat es zugemacht, he has opened the window, and she has shut it.

In der That (*lit.*, "in the deed") answers to the English *indeed*, "in reality," as:—Ich weiß in der That nicht, was ich davon denken soll, I really do not know what to think of it; Die Freundschaft scheint mir in der That besser (Gellert), friendship appears indeed to me better.

Zu Stande bringen = "to bring to a stand *or* point"—that is, "to bring to pass," "to accomplish," as:—Guter Wille und Ausdauer vermögen viel zu Stande zu bringen, good-will and perseverance can accomplish much.

Langeweile, compounded of lang (long) and Weile (while *or* time) = "tediousness," "weariness," "heaviness," as:—Was den Thoren vergnügt, macht dem Weisen gewöhnlich Langeweile, that which delights fools, generally causes weariness to the wise (man). Sich langweilen = "to become weary," as:—Die Rede war sehr langweilig, deßwegen langweilte er sich, the discourse was very wearisome, therefore he became weary. Langweilen = "to cause tediousness," "to bore," as:—Er langweilte uns mit seinem Gespräch, he wearied us with his talk.

EXAMPLES.

Er hat während seiner Krankheit gar nichts genossen.	During his sickness, he has eaten nothing at all.
Der Knabe will ein wenig bei seinem Oheim bleiben.	The boy wishes to remain a little (while) with his uncle.
Ich habe heute zu'fälliger Weise einen alten Bekann'ten getroff'en.	I have accidentally met an old acquaintance to-day.
Ich weiß in der That nicht, was ich thun soll.	I really (indeed) do not know what I ought to do.
Er getraut' sich nicht in das Wasser (zu gehen).	He does not venture into the water (to go into the water).
Haben Sie es schon zu Stande gebracht?	Have you already accomplished it?
Der Knabe schlief ein am grünen Gesta'de (Schiller).	The boy fell asleep on the green shore.
Das Geschwätz' der Menge langweilt ihn.	The tattle of the crowd bores him.
Er leidet an Langewei'le.	He is troubled with ennui.

VOCABULARY.

An'rathen, to advise, counsel.
Auseinan'dergehen, to go asunder.
Ein'schlafen, to fall asleep.
Gene'sen, to recover.
Gene'sung, *f.* recovery, convalescence.
Gespräch', *n.* talk, conversation, dialogue.
Getrau'en (sich), to dare, venture.
Kehren, to turn, mind, care for, regard.
Lage, *f.* state, condition, situation, site, seat.
Mü'digkeit, *f.* weariness, fatigue.
Trotzdem', notwithstanding.
Urtheil, *n.* judgment.
Vertraut', confidential, intimate.
Vielleicht', perhaps, possibly.
Voran'schreiten, to proceed, progress.
Vorher', before, beforehand.
Wählen, to elect, choose.
Wandern, to wander, walk.
Weise, *m.* philosopher.
Zeugniß, *n.* witness, testimony, deposition.
Zu'fällig, accidentally, casually.
Zu'hörer, *m.* auditor, hearer, *pl.* auditory.

EXERCISE 164.

Translate into English:—

1. Der Kranke will nichts genießen, trotzdem, es ihm vom Arzte angerathen worden ist. 2. Er hat nur ganz wenig bei uns genossen. 3. Mein Bruder ist wieder von seiner Krankheit genesen. 4. Die Genesung schreitet bei diesem Kranken nur langsam fort. 5. Die Kirche geht um halb elf des Morgens an, und um halb zwölf ist sie gewöhnlich aus. 6. Er machte ihn zu seinem vertrautesten Freunde, ohne ihn vorher geprüft zu haben, oder sonst ein Zeugniß über seine Treue und Verschwiegenheit zu haben. 7. Nicht wähle zum Vertrauten einen Jeden du, das leere Haus ist offen, das reiche zu, . wähl' Einen dir, und suche nicht den Andern, bald wird, was Deiner wissen zu Allen wandern. 8. Kommen Sie vielleicht diesen Nachmittag ein wenig zu mir? 9. Kommen Sie vielleicht diesen Abend in das Concert? 10. Er hängt von Niemanden ab, er lebt, wie es ihm gefällig ist. 11. Er steht des Morgens auf, wann es ihm gefällig ist, das eine Mal früh, und das andere Mal spät 12. Er spricht und handelt, wie es ihm gefällt, ohne sich an das Urtheil der Leute zu kehren. 13. Ich habe ihn zufällig zu Hause angetroffen. 14. Zufällig traf ich ihn im Theater. 15. Es ist in der That nicht so leicht, sich in alle Lagen des Lebens geduldig zu schicken. 16. Es ist in der That wahr, was diese

Frau gesprochen hat. 17. Was sich Keiner getraute, hat dieser zu Stande gebracht. 18. Er hat die Sache zu Stande gebracht. 19. Das Kind schlief aus Müdigkeit ein. 20. Die Gesellschaft langweilte sich sehr, und ging früh auseinander. 21. Er langweilte nicht nur mich, sondern auch meine Freunde.

EXERCISE 165.

Translate into German:—

1. Why have you opened the window? 2. It is so very warm in the room, and I like to enjoy the fresh air. 3. I pray you shut the window and open the door. 4. Shut the door, that the window might be open. 5. Really I do not know what to do with this son of mine; he will not listen to my advice. 6. Most of his auditors fell asleep during his long speech. 7. A good work can only be accomplished through attention. 8. My daughter's recovery proceeds but slowly. She will not eat, notwithstanding she is advised by the physician.

KEY TO EXERCISES.

Ex. 150.—1. He hesitated to entrust the gold watch to the stranger. 2. The father hesitated to believe everything that his son told him. 3. He who hesitates too much gains little. 4. They believed him to be a respectable man. 5. I took him for the mayor of this town. 6. We thought he was something quite different. 7. The young bookseller has published a new work. 8. Has Mr. N.'s new grammar been published yet? 9. It has just appeared at Mr. N.'s publishing-office. 10. I am entirely at a loss what to do in this matter. 11. The mother is embarrassed because she has forgotten the name of the street. 12. He is at a loss to know whence he may get the twenty dollars that he requires. 13. She is embarrassed about the sudden appearance of a stranger. 14. Shall we play a game at chess or at billiards? 15. I prefer a game at chess, because at this game more judgment than skill is required. 16. Do you like chess? 17. Oh, yes; but I have very little opportunity to play it, wherefore I am very often checkmated by good players. 18. Do you play an instrument? 19. Yes, I play the piano, and have begun to play the violin within a few days. 20. Are you more fond of playing the violin than the piano?

Ex. 151.—1. Er trug Bedenken, seinem Anwalte die Sache anzuvertrauen. 2. Die Mutter trug Bedenken, Alles zu glauben, was ihre Tochter ihr erzählte. 3. Ich habe Ihr Buch verlegt, und bin deßhalb in großer Verlegenheit. 4. Das Kind hinterging seinen Lehrer, weßhalb derselbe Bedenken trug, ihm wieder zu glauben. 5. Er spielte Billiard, und verlor all sein Geld. 6. Wollen Sie eine Partie Schach mit mir spielen? 7. Nein, ich ziehe eine Partie Billiard vor, denn ich verstehe nicht viel vom Schach. 8. Spielen Sie irgend ein Instrument? 9. Ja, ich spiele Klavier, und habe vor die Violine zu lernen. 10. Besitzt Ihre Schwester Fertigkeit auf dem Klavier? 11. Nein, aber sie spielt meisterhaft auf der Harfe. 12. Bei dieser Frage verlor er alle Fassung, und wußte nicht, was er antworten sollte. 13. Herr C. in London wird bald die Geschichte der Könige von England herausgeben.

Ex. 152.—1. It is a pity that you did not come an hour earlier. 2. Do it as you please; anything suits me. 3. Everything that the assembly has decided upon pleases me. 4. He was obliged to submit silently to this offence. 5. He was obliged to put up with many things that he would not have submitted to under other circumstances. 6. She was obliged to submit to be calumniated. 7. On the right hand we had the chain of mountains, and on the left the river. 8. Right and left hostile troops were drawn up. 9. You must not turn from this road, neither to the right hand nor to the left. 10. Who is the cause of this accident? 11. Our neighbour is the cause. 12. It is the scholar's fault that he is punished. 13. We ourselves have been in fault. 14. To-morrow week a steamboat arrives from New York. 15. To-morrow fortnight it will be a year since I saw him. 16. Yesterday week his father died. 17. The young girl accompanied her song with a guitar. 18. The friend accompanied the Italian's violin music with the pianoforte. 19. The accompaniment of these songs is by Mozart. 20. Many things would appear to us natural if we would subject them to a proper examination.

Ex. 153.—1. Es ist Schade, daß Ihr Freund nicht eine halbe Stunde früher angekommen ist. 2. Ich muß mir gefallen lassen, was mein Vater auch beschließt. 3. Johann's neues Buch gefällt mir sehr. 4. Man muß sich Vieles in diesem Leben gefallen lassen. 5. Ich würde es mir nicht gefallen lassen, wenn ich an Ihrer Stelle wäre. 6. Zur Rechten hatten wir den Fluß, und zur Linken das Waldgebirge. 7. Rechts und links sahen wir nichts als feindliche Truppen. 8. Heute über acht Tage gehen wir nach Berlin. 9. Morgen über vierzehn Tage wird mein Bruder hier ankommen. 10. Ein Schiff segelte gestern vor acht Tagen nach Australien. 11. Vor drei Tagen hatten wir unerwartet ein großes Vergnügen. 12. Es ist Schade, daß die Talente dieses jungen Künstlers nicht besser ausgebildet sind. 13. Ihre Schwester begleitete mich auf der Harfe, und sang zur Klavierbegleitung meines Freundes. 14. Es ist ganz natürlich, daß jeder Mensch sterben muß. 15. Die Begleitung dieses Stückes ist von Händel.

Ex. 154.—1. To many people it seems to afford a pleasure to offend others. 2. I perceived that he felt himself offended. 3. He offended not only me, but also my uncle. 4. This affair has already caused me great trouble. 5. The profligate son causes the father great trouble. 6. It grieves the teacher to have stubborn scholars. 7. This speech vexed many persons present. 8. The angry boy left his work. 9. The friend was vexed because I did not answer his letters. 10. I owe my deliverance to him. 11. Consequently I owe him everything, next to God. 12. If it does not alter soon, I shall run away. 13. On such occurrences one might run away. 14. The boy's little dog has run away. 15. It becomes the judge to inquire into the cause of this disturbance. 16. It behoves me to be silent about this matter. 17. The inquisitive man is wont to look about for every trifle. 18. In order to look about a little, I went to the town. 19. My friend intends to look out for another lodging. 20. I praise the olden times. 21. I praise the beautiful rooms and the friendly hospitality. 22. The horses took fright and ran away with us.

Ex. 155.—1. Es geziemt einem Kinde nicht, seinen Eltern zu widersprechen. 2. Ich ging in die Stadt, um mich umzusehen. 3. Ich bewundere diese schönen Zimmer und deren freundliche Lage. 4. Der Dieb ging mit dem Gelde durch, ehe es möglich war, ihn einzuholen. 5. Aus Furcht, daß man ihn auf der That ergreifen möchte, lief er

davon. 6. Es ist eine verdrießliche Sache, daß er mein Geld verloren hat. 7. Ich merke, daß dieses kleine Geschenk Ihnen gefällt. 8. Ich merke es ihm an, daß er nicht die Wahrheit gesagt hat. 9. Sehen Sie sich nach Ihrem Vater um? 10. Nein, ich sehe mich nach meinen Freunden um. 11. Ich lobe die fleißigen Schüler 12. Falle mir nicht, Kindchen. 13. Mein Bruder schießt einen Vogel auf achtzig Schritt vom Baum.

HYDRAULICS.—V.

(Continued from Vol. IV., p. 372.)

HYDROMETRY.

DENSITY—RELATIVE DENSITY—SPECIFIC GRAVITY—DETERMINATION OF SPECIFIC GRAVITY OF SOLIDS—TABLE GIVING DENSITY OF WATER—CORRECTIONS FOR SPECIFIC GRAVITY—SOLIDS LIGHTER THAN WATER—SPECIFIC GRAVITY OF LIQUIDS — HYDROMETERS — FUNDAMENTAL PRINCIPLE—COMMON HYDROMETER—GRADUATION OF A HYDROMETER—SIKES HYDROMETER — DERHAM'S IMPROVED SIKES—TWADDELL HYDROMETER — BAUMÉ HYDROMETERS — NICHOLSON AND FAHRENHEIT HYDROMETERS—MOHR'S SPECIFIC GRAVITY BALANCE.

By the *mass* of a body is meant the quantity of stuff or matter making up the body, or of which it is composed. It is owing to the downward pull of the earth upon this matter or stuff that a body is said to have weight. The same quantity of stuff may occupy either a large or small bulk depending on whether the stuff is loosely distributed in the one case, and compact, dense, or compressed in the other. The *mass of unit volume of a substance is called the density of it.*

Thus, if we let

V stand for the volume of a body,
M " " mass of the body,
and D " " density of the body,

then the quotient

$$\frac{\text{mass}}{\text{volume}} = \text{mass of unit volume} = \text{density},$$

that is to say,

$$\frac{M}{V} = D, \text{ or } M = VD.$$

Relative density is the ratio of the mass of any volume of a substance to the mass of an equal volume of some standard substance. But at any given place, the total downward pull of gravity on a body, usually called the *weight* of the body, is directly proportional to the quantity of matter in the body; consequently the masses of two bodies may be compared by simply weighing the bodies, and the relative density of a substance is simply the ratio of its weight to that of the same bulk of the standard substance.

Water at a definite temperature. 4° Cent. or 39° Fahr., and under atmospheric pressure, is usually taken as the standard substance. Then the common term. the specific gravity *of a substance, is simply the ratio of its weight to that of the same bulk of water.*

When s stands for the specific gravity of a body, and d stands for the density of water at the standard temperature, we have,

$$D = sd, \text{ and } M = Vsd.$$

The weight of a cubic foot of cold water is about 62·4 lb., or more nearly 1,000 oz. Hence if we select a cubic foot as the unit of volume, and measure mass in lb., the density of the standard substance water is $d = 62·4$.

It is sometimes more convenient to reckon from the standard gallon. Thus a standard gallon pot holds 10 lb. mass of water at 39° Fahr., or 4° Cent. Now we have to recollect that *specific gravity of a body means the number of times the body is as heavy as water.* So that if a gallon of oil weighs 8·25 lb., whilst a gallon of water weighs 10 lb., then

$$\text{Specific gravity of the oil} = \frac{\text{weight of oil}}{\text{weight of water}},$$

$$= \frac{8·25}{10} = ·825.$$

In actual practice, in order to avoid decimal fractions, the specific gravity of water is taken as 1,000 instead of unity, so that the specific gravity of the oil in this instance would be said to be 825.

The C.G.S. system is still more convenient, having the cubic centimetre as the unit of volume and the gramme as the unit of mass, since a cubic centimetre of distilled water at its maximum density point, 4° Cent., weighs exactly one gramme. Thus the *volume of a body, expressed in cubic centimetres, is numerically equal to the weight of an equal bulk of water at 4° Cent., expressed in grammes.* It follows that we can readily determine the volume of an irregular mass by weighing the water displaced by it. For instance, to find the density of a lump of Cornish gold:—

1st. Weigh the lump of mineral carefully in air, or for greater accuracy in vacuo. It is found to weigh 72 grammes in air.

2nd. Immerse the lump in a beaker of distilled water, taking care to get rid of all air-bubbles. The water displaced by the lump of Cornish gold may be collected and measured in a graduated glass, when it is found to occupy 16 cubic centimetres. Therefore this bulk of water weighs 16 grammes; or, remembering the principle of Archimedes, that a body immersed in a fluid is buoyed up by a force equal to the weight of the fluid displaced, we may observe the *apparent weight* of the lump of Cornish

gold in water, *then* the difference between this apparent weight in water and the *real* weight in vacuo, or practically in air—that is, the loss of weight in water is equal to the weight of the water displaced. In this way we find the weight of a piece of water of the same size as the lump of mineral is 16 grammes. Then

$$\frac{\text{weight of mineral}}{\text{weight of same bulk of water}} = \frac{72}{16} = 4{\cdot}5.$$

$$\text{or, specific gravity} = \frac{\text{real weight of body,}}{\text{loss of weight in water.}}$$

The mineral is four and a half times as heavy as water, therefore its specific gravity is 4·5.

Again, we have found the mass of the lump of mineral is 72 grammes, and its volume is 16 cubic centimetres, therefore the density or mass of unit volume is

$$\frac{\text{mass in grammes}}{\text{volume in cubic c.m.}} = \frac{72}{16} = 4{\cdot}5.$$

In this way we have a rough and ready method of determining the specific gravity of a solid body insoluble in water, by means of a hydrostatic balance; find

W = apparent weight of body in air,
W' = apparent weight of body in water,

so that,

$W - W'$ = loss of weight in water,
= weight of water displaced.

Then,

$$\text{Specific gravity, } S = \frac{W}{W - W'}.$$

For example.

A certain coin weighed in air = 15·48 grammes,
and the same „ „ water = 14·58 „

∴ Weight of water of same bulk
as coin = 0·90 „

and

$$\therefore \text{ specific gravity of coin} = \frac{15{\cdot}48}{0{\cdot}90}$$
$$= 17{\cdot}2.$$

Hence the coin is more than 17 times as heavy as water, bulk for bulk.

Obviously, for anything approaching strict accuracy we should take into account the density of the water at its observed temperature when the body was weighed in it. Thus, at 15° Cent. the density of pure water is 0·999125, so that the specific gravity of the coin compared with water at 4° Cent. is

$$17{\cdot}2 \times {\cdot}999125 = 17{\cdot}185.$$

According to Despretz, the following figures give the density of water at various temperatures:—

Temperature (Centigrade)	Volume.	Density.
−5° C.	1·0006987	0·999302
−2°	1·0003077	0·999692
0°	1·0001269	0·999873
2°	1·0000331	0·999966
4°	1·0000000	1·000000
5°	1·0000082	0·999990
10°	1·0002684	0·999731
14°	1·0007140	0·999285
15°	1·0008751	0·999125
20°	1·00179	0·998213
40°	1·00773	0·992329
60°	1·01698	0·983303
80°	1·02885	0·971959
100°	1·04315	0·958634

Further, it is evident that the apparent weight of the body in air will vary with the density of that fluid, which depends on its temperature and pressure, since the body is buoyed up by the air with a force equal to the weight of the air displaced.

In accurate determinations of specific gravity it is necessary to observe the temperature t° Cent., and the pressure of the air—say in millimetres of mercury as height of barometer, when the body was weighed in it. From these data the weight of the volume of air displaced may readily be calculated, taking the weight of dry air as 0·0807 lb. per cubic foot, or, more accurately, 1·2927 gramme per litre at 0° Cent., and 760 mm. of mercury pressure at the sea-level at lat. 45° N. The formula for the weight of v cubic centimetres of dry air at temperature t° Cent., and pressure H mm. of mercury, is

$$\text{Weight of } v \text{ c.c. of air} = v\,\frac{{\cdot}0012927}{1 + {\cdot}00367t} \cdot \frac{H}{760}.$$

Hence the true weight of the body in vacuo can be found as in last lesson. (*See also* page 44.)

Moreover, for the sake of comparison with other substances, the specific gravity of the body at the observed temperature has to be reduced to 0° Cent. Since the density is inversely proportional to the volume, we must know the co-efficient of cubical expansion, b, for the given substance. If v be volume, at t° Cent. and v_0 at 0° Cent.,

$$v = v_0\,(1 + bt).$$

Then a body of density S at t° Cent. will, when reduced to 0° Cent., have density inversely as the volume.

For bodies lighter than water we may use a sinker, usually made of lead, or other heavy material of sufficient weight to make the body sink.

Let weight of the sinker in water = s
„ „ „ body in air = w
and „ „ body and sinker together in water = w'

Then the force required to immerse the body is

$s-w'$; this, together with w, the weight of the body in air, gives the weight of water displaced. Hence,

$$\text{specific gravity of the body} = \frac{w}{w+s-w'}.$$

Corrections must first be made for the density of the water, and that of air (σ) at the observed temperature, so that the true specific gravity of the body at that temperature is

$$\frac{w(\rho-\sigma)}{w+s-w'}+\sigma.$$

In case the co-efficient of expansion is known, this specific gravity may be reduced to 0° Cent.

Any other liquid that does not dissolve the body or act chemically on it may be employed, and the result, multiplied by the specific gravity of the liquid at that temperature, gives the true specific gravity of the body immersed.

Specific Gravity of a Liquid.

When a solid body is weighed in air and also in different liquids which do not act chemically on it, the loss of weight in each liquid is equal to the weight of *that* bulk of the liquid displaced by the solid body. Similarly, the loss of weight in water is equal to the weight of that bulk of water displaced. Suppose we find by experimenting in this way that a certain solid body weighed as follows:

Apparent weight in air $= w$ grammes.
" " in water $= w'$ "
" " in liquid $= l$ "

Thus,

$w-w'$ = weight of given bulk of water displaced,
$w-l$ = weight of same bulk of liquid displaced,

$$\therefore \frac{w-l}{w-w'} = \frac{\text{loss of weight of solid in liquid}}{\text{loss of weight of solid in water}},$$
$$= \frac{\text{weight of given bulk of liquid}}{\text{weight of same bulk of water}},$$
$$= \text{specific gravity of liquid.}$$

HYDROMETERS.

The *hydrometer* is an instrument which tells the density or specific gravity of liquids either by (1) the depth it sinks in the liquid; or by (2) the weights required to sink it to a given depth in the liquid. The latter class are known as constant immersion hydrometers, since the same bulks of liquids are compared, and the former, hydrometers of variable immersion for varying bulks of the same weight. Unfortunately there are different scales used not only for different purposes, but even for the same special work hydrometers have entirely different graduations. Besides, hydrometers are called by a great variety of names: ***alcoholimeters***, to find the amount of alcohol in a liquid; ***spiritometers***, to measure the proportion of acid or spirit; ***saccharometer***, to find strength of sugar solutions; ***lactometers***, to test quantity of water in milk; ***barkometers***, used by tanners for bark solutions; and many other such instruments and devices used in technical operations.

The construction of the hydrometer depends upon the principle that *the weight of the floating body is equal to the weight of the liquid displaced.*

Suppose we take a piece of wood, say oak, one square inch in section, and 14 inches long, and therefore made up of 14 cubic inches of oak. When this piece of wood is dipped into a vessel containing water, it sinks to a certain depth, displacing some water and raising the water level until the weight of water displaced is exactly equal to that of the wood which it buoys up. When guided upright the wood sinks to about 10 inches in water. Hence 10 cubic inches of water weighs the same as 14 cubic inches of wood.

$$\therefore \frac{10}{14} = \cdot714 = \text{specific gravity of the oak.}$$

Now we can use this stick of oak to find the specific gravity of other liquids. This oak only sinks nine inches deep in brine, and therefore, since both equal the weight of the stick, 9 cubic inches of brine weigh the same as 10 cubic inches of water,

$$\text{hence the specific gravity of brine } \frac{10}{9} = 1\cdot\dot{1}.$$

In methylated spirits the oak sinks 12·5 inches,

$\therefore$ 12·5 cubic inches of spirit = 10 cubic inches of water,

$$\therefore \text{ specific gravity of spirit} = \frac{100}{125} = \cdot8.$$

Generally, then,

$$\frac{\text{Length or depth to which the wood sinks in water}}{\text{Length to which it sinks in the liquid}} = \text{specific gravity of that liquid.}$$

$$\therefore \text{Specific gravity of liquid} = \frac{1}{\text{length oak sinks in it.}}$$

Evidently it is convenient to graduate the floating body, so that the reading at the point to which this hydrometer sinks in the liquid gives the specific gravity of that liquid directly.

COMMON HYDROMETER.

The common hydrometer consists of a glass tube containing some mercury in a bulb at the bottom of the stem to make it float vertically in any liquid, and the depth to which the instrument sinks indicates the specific gravity of the liquid, which is recorded on the stem. It is obvious that the instrument will sink deeper the less the specific gravity of the liquid, since the weight of the

liquid displaced must be equal to that of the instrument which floats in it.

Fig. 12.

Consequently the stem is graduated downwards, starting with zero at the top for the liquid of least density it is intended to measure. The greater the density of the liquid in which it floats, the more of the stem will emerge above the surface of the liquid: and the specific gravity is given, if that corresponding to zero on the scale is known, by simply adding on the scale reading at the surface of the liquid. It is still more convenient to have the specific gravity marked on the scale divisions so as to be read off directly.

TO GRADUATE A HYDROMETER.

We must remember that the weight W of the instrument remains constant, and

if V = volume of the part of hydrometer immersed,

and S = specific gravity of the liquid,

then W = VS.

As the density of the liquid *increases* by equal amounts, b, in arithmetical progressions, 1, $1 + b$, $1 + 2b$, $1 + 3b$, etc., the corresponding volumes immersed decrease thus: V, $\frac{V}{1+b}$, $\frac{V}{1+2b}$, $\frac{V}{1+3b}$, etc., in harmonical progression, so that

$$W = VS = V'S' = V''S'', \text{ etc.}$$

Consequently the bulk of the corresponding divisions of the stem must diminish in proportion to the reciprocals of the specific gravities.

In order to extend the range of such a hydrometer, and at the same time keep equal divisions on the scale, the device has been adopted of using a series of weights, called poises, placed at the lower end of the instrument.

SIKES HYDROMETER.

The Sikes hydrometer, which is used in the Customs and Excise in England to determine the amount of alcohol in spirits, has nine poises made of gilded brass. The instrument was simply intended to give the relative strength of spirits, and a table of specific gravities has been adapted to the divisions on the scale.

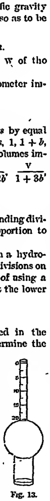


Fig. 13.

An improved form of the Sikes hydrometer has been brought out by Dr. Derham. It consists (Fig. 13) of a hollow brass ball gilt over. The brass stem is graduated from top 0 to 20, near the ball. There is a light stirrup and socket underneath, into which a series of poises fit exactly. Each poise has a definite weight and bulk, and consists of a cylindrical piece of ebonite with a circular platinum disc of carefully adjusted weight fixed into the bottom of the cylinder.

The instrument without any weight measures the gravity of liquids from ·780 up to ·800. For heavier liquids the smallest poise marked ·800 is fixed in the stirrup, and by adding on the scale-reading, the specific gravity of liquids can be read to ·820. Then the next poise takes up the series from 820 to 840, and so on till the last poise marked 980, and 20 on scale-reading, gives 1·000 for distilled water at 60° Fahr. By means of these carefully adjusted poises, this instrument gives the specific gravity directly.

TWADDELL HYDROMETER.

In England the Twaddell hydrometer is used for liquids heavier than water. In this instrument the divisions are not at equal distances apart, but are closer together at the bottom, according to the harmonical law for equal differences of density. The numbers on the scale do not denote density, but the specific gravity is found by the rule:—*Multiply the hydrometer reading by 5, and add* 1000. Thus the reading 5 degrees indicates specific gravity of $5 \times 5 + 1000 = 1025$, compared with water as 1000, or 1·025 with water as 1.

Similarly, 15 degrees on Twaddell's scale means specific gravity $15 \times 5 + 1000 = 1075$, or 1·075.

When the range of one stem is exhausted, then another instrument of heavier bulb, etc., is selected to continue the readings for liquids of still higher specific gravity.

BEAUMÉ HYDROMETERS.

In the hydrometers of Beaumé, which are greatly used on the Continent, the divisions on the scale are equidistant.

There are two such instruments with different graduations—one for liquids lighter, and the other for liquids heavier than water. The latter instrument, called a salimeter, when immersed in distilled water, sinks to a point marked zero near the top of the scale. When immersed in a solution containing 15 parts by weight of salt to 85 of water, the point to which it sinks is marked 15. The interval between these two points is divided into 15 equal parts. Tables of values are given for the scale divisions, but authorities differ considerably as to the exact values of the specific gravity corresponding to the readings on this instrument.

The alcoholimeter, for liquids lighter than water, has the zero point at the bottom of the scale to which the instrument sinks in a solution of 10

parts by weight of common salt to 90 parts of water; whilst the second point to which it sinks in distilled water is marked 10. The interval is divided into 10 equal parts, and the graduations numbered upwards.

The Nicholson and Fahrenheit constant immersion hydrometers offer such difficulty of adjustment by weights in order to sink them exactly to a fixed point that they have been superseded for commercial purposes by the variable immersion hydrometer.

MOHR'S SPECIFIC GRAVITY BALANCE

is so adjusted that when the float hangs from one arm the balance is in equilibrium. This arm of the balance is graduated to suit small riders of three sizes for three places of decimals, so that when the float is completely immersed in distilled water at 15° Cent., there is equilibrium with the largest rider hung on this extreme end of the arm. The instrument is convenient for rapid work, and may be used for a very wide range, from the specific gravity of air to that of liquids 2 or 3 times as heavy as water.

ENGLISH.—XXV.

[*Continued from Vol. IV., p. 340.*]

EXERCISES.

IF the student desires to take the fullest advantage of the passages we quote from the works of English authors, he will not only read them aloud, but attempt to write them out afterwards in his own words.

THE LOVE OF KNOWLEDGE.

But while I am descanting so minutely upon the conduct of the understanding, and the best modes of acquiring knowledge, some men may be disposed to ask, "Why conduct my understanding with such endless care?—and what is the use of so much knowledge?" What is the use of so much knowledge?—what is the use of so much life?—what are we to do with the seventy years of existence allotted to us?—and how are we to live them out to the last? I solemnly declare that, but for the love of knowledge, I should consider the life of the meanest hedger and ditcher as preferable to that of the greatest and richest man here present. For the fire of our minds is like the fire which the Persians burn in the mountains—it flames night and day, and is immortal and not to be quenched! Upon something it *must* act and feed—upon the pure spirit of knowledge, or upon the foul dregs of polluting passions. Therefore, when I say, in conducting your understanding, love knowledge with a great love, with a vehement love, with a love coeval with life, what do I say but love innocence—love virtue—love purity of conduct—love that which, if you are rich and great, will sanctify the blind fortune which has made you so, and make men call it justice; love that which, if you are poor, will render your poverty respectable, and make the proudest feel it unjust to laugh at the meanness of your fortunes; love that which will comfort you, adorn you, and never quit you—which will open to you the kingdom of thought, and all the boundless regions of conception, as an asylum against the cruelty, the injustice, and the pain that may be your lot in the outer world; that which will make your motives habitually great and honourable, and light up in an instant a thousand noble disdains at the very thought of meanness and fraud! Therefore, if any young man here have embarked his life in the pursuit of knowledge, let him go on without doubting or fearing the event; let him not be intimidated by the cheerless beginnings of knowledge, by the darkness from which she springs, by the difficulties which hover around her, by the wretched habitations in which she dwells, by the want and sorrow which sometimes journey in her train; but let him ever follow her as the angel that guards him, and as the genius of his life. She will bring him out at last into the light of day, and exhibit him to the world comprehensive in acquirements, fertile in resources, rich in imagination, strong in reasoning, prudent and powerful above his fellows, in all the relations and in all the offices of life.—*Sydney Smith.*

CHARLES EDWARD ENTERING HOLYROOD.

On the 13th of September the little army of Charles crossed the Forth, and, animated by every fear, the terrified men of Edinburgh made a show of standing to their colours. But this parade was not fated to last long. On the 16th, the Prince's advanced guard were at Kirkliston, within a few miles of the city, where the consternation increased every moment, until the volunteers began to bribe with sixpences every soldier they met, to take their arms to the castle. The arrival of the Prince was awaited by the Whigs with doubt and dismay, and by the Jacobites (at the head of whom was the Provost) with an exultation which they took very little pains to conceal. Certain commissioners were sent to Gray's Mill, to treat with the Highland chiefs for delivering the keys of the city on the best terms. Of what passed at the conference nothing is known, but, by a preconcerted arrangement (it is supposed) between them and the Prince, the city was surprised next morning at four o'clock. A soldier of the city guard, sentinel at the Netherbow, stopped a hackney coach that approached his post. "Open the Port!" cried the driver, "for I behove to get out." "You cannot," replied the sentinel, "without an order from Provost Stuart." "Provost Coutts hath ordered me to be let out," replied the driver whipping up his horses. The soldier still remonstrated, when James Gillespie, under-keeper of the Port, said—"Let out the coach instantly, for I have an order to that effect." "Oh, sir, 'tis well that you have the keys of the Port and must answer for it," replied the soldier, and pulled back the ponderous gate in the arch between the towers. The moment the coach passed out, a Highlander sprang in, and in the twilight, grasped the sentinel, and wrested his musket from him. It was the chieftain of Lochiel; and immediately the whole Clan Cameron, 900 strong, with swords drawn and banners displayed, all clad in their native tartan, marched up the High Street with twelve pipers before them, making the lofty houses ring, and awakening the terrified citizens with the stirring air of—

> 'We'll awa to Shirramuir,
> And haud the Whigs in order."

About mid-day, the main body of the Highland army, making a circuit by the ancient Tower of Merchiston, marched west by the Grange Loan, a narrow road, between old walls and aged trees, and thus avoiding the castle guns, arrived in the King's Park, where the young Prince, arrayed in the national garb, which displayed to advantage his tall and handsome figure, and wearing on his left breast the Order of the Thistle—was received with acclamation by the people. Surrounded by his Highland guard—all veterans of Sheriffmuir and Glenshiel, men verging on eighty years of age, and distinguished by snow-white beards and Lochaber axes—the

Prince approached the great gate of the palace, and there he paused; for at that moment a twenty-four pound shot, fired from the castle, struck the front wall of James V.'s Tower, near the window that lights the state apartments of Queen Mary. It dislodged several stones, and they fell together into the court. In this incident there was something so peculiarly insulting to the descendant of the Stuarts when standing on the very threshold of their desolate palace, that a simultaneous groan burst from the spectators; a shout of acclamation followed, and the Prince again approached the gate, but again paused, and looked round him irresolutely, for there was no Lord Keeper, no Earl Marischal, no Great Chamberlain, no Master of the Household, to usher him into ancient Holyrood, till a gentleman sprang from the crowd, raised his hat, and drawing his dress-sword, led the way to the state apartments, while another shout of applause burst from the people. In absence of his father, the Prince was proclaimed Regent of Britain by the heralds, at the cross, around which Lochiel, with his Camerons, and several ladies on horseback with drawn swords, acted as guard; the first for safety, the last for honour and enthusiasm. The Highlanders stayed within their camp, or, when in the city, behaved themselves with the utmost order and decorum; no outrages were committed, and no brawls of any kind ensued.—*Memorials of the Castle of Edinburgh*, pp. 225-228.

CONSONANTS.

What we have now said practically concludes the subject of vowels, though readers familiar with French will probably notice that nothing has been said about nasal vowels. But we are purposely postponing the consideration of this comparatively small class of vowels until we have dealt with that most important branch of spoken sounds called consonants. When the reader has acquired a full grasp of the general subject of consonants, and the general subject of vowels, he will find it very easy to supplement his knowledge by the consideration of nasal consonants and nasal vowels.

Let us recur then to the broad distinction drawn in a previous lesson between consonants and vowels. This distinction, it will be remembered we said, depends finally on whether the mouth and its appurtenances, the tongue, teeth, and lips, are in such position that the breath in passing them is subject to friction or interruption so as to make a distinct sound. Or to express the same distinction in another way. In making a vowel sound, the organs of speech are placed in the position appropriate to the particular vowel to be formed, and are left in that position during the whole period of the formation of the vowel. The whole sound of a vowel is thus due to the vibration of a peculiarly shaped column of air, plus the vibration of the vocal chords as described above. On the other hand, in making a consonant sound, there is, during the progress of the formation of the sound, a change in the position of the organs of speech, and this change produces an audible effect; in fact, we may, if we like, say that this audible effect *is* the consonant.

Thus, for example, take the consonant *p*. To form the sound represented by this letter, the lips are brought together and then suddenly opened. A little explosion is heard, and this explosive sound is the consonant *p*. Again, take the consonant *f*. The upper teeth are placed in contact with the lower lip, and the breath is forced through the narrow passages left. Here, there is no sudden explosion, but the sound is due to a continuous friction of the breath against the surface of the lips and the edges of the teeth. Another form of consonant slightly different in character both from *p* and *f*, is the trilled *r*. The tongue is here placed against the forward portion of the palate, and is there allowed to vibrate, breath being at the same time forced past it out of the mouth. The successive interruptions to the current of the air as it rushes past give rise to the trilled sound.

Thus, in all these three cases of quite distinct species of consonants, it is seen that the sound is due not to the vibration of a column of air, as in the case of a vowel, but to some *audible interruption* in the stream of air as it leaves the mouth. In the case of *p* the interruption is of an explosive character, and an "explosive" consonant is produced. In the case of *f* the interruption is continuous, producing friction, and such a consonant we call a "continuant." Lastly, in the case of *r*, the interruption repeats itself, a series of little knocks, as it were, are heard, and we call the sound a "trill."

The distinction between vowels and consonants ought now to be sufficiently clear to the student, but there is still one point to be emphasised—namely, the actual meaning of the word "consonant" itself. Probably most of the readers of these lessons are well aware that the word *consonant* comes from a Latin word which means *sounding together*. And when we learnt grammar at school, we were most of us taught that a consonant is so called because it cannot be sounded except together with a vowel. Broadly speaking, this statement is quite correct, but it is necessary to examine it in detail if we wish to be sure of thoroughly understanding our subject. To test the statement, try to say *p* without a vowel following. Bring the lips together, and then suddenly open them, but be very careful that nothing in the nature of a vowel is allowed to escape at the same time. With a little trouble this *can* be done. The explosive sound which we have defined to be the consonant will be heard and nothing else. Now take *f*. Here much less difficulty will be experienced. Having placed the upper teeth upon the lower lip, we can go on expelling air and making an audible hiss as long as we like, and yet no vowel will be heard. So

also can we do in the case of the trilled *r*. Therefore it is not quite true that a consonant requires of necessity the assistance of a vowel in order to be heard. But this is true, that it is comparatively so difficult to form a consonant sound alone, that while we frequently in speech do use vowels by themselves, we never use consonants except with vowels. And this distinction is brought out even more plainly in singing. A singer always dwells on the vowels in a word, takes his note upon the vowel in fact, but glides hastily over the consonants. That is because a vowel being merely the vibration of a column of air, all that is necessary is to graduate this column, if we may so express it, to the proper pitch, and then prolong the sound indefinitely. But a consonant involving interruption of the breath as it leaves the mouth, of necessity hampers the singer in the production of his note. In just the same way it may be noticed that a person shouting to someone at a distance dwells on the vowels in each word, because he can with ease increase their intensity, whereas it is extremely difficult to emphasise a consonant.

We have just said that while consonants are never used alone, in ordinary speech vowels frequently are. In English we have the article *a*, the pronoun *I*, the exclamations *ō* and *ā*, generally spelled *oh*, *ah*; while in French the common words *a*, *à*, *et*, *est*, are are all simple vowels. But since we have seen that it is possible to pronounce consonants alone, is there no case of a single consonant forming a word itself? Yes, there is at least one, if we can call it a word—namely, the ordinary hiss at a theatre. And the clack which a driver often makes with his tongue to encourage his horses, might possibly be described as a word formed of a single consonant. It is said that the Zulus have several words of this character made with consonantal clicks, and perhaps if we were inventing the English language afresh, we might decide that the prolonged consonant *f* should by itself express the idea now conveyed by the word fie! and that a trilled *r* should denote indignation or anger.

We have now sufficiently emphasised the essential distinction between vowels and consonants, and our next work is to classify the consonants on the same lines as we previously adopted for the classification of vowels. It will be remembered that in dealing with the vowels we decided that the only possible way to classify them was by noting the position and shape of the tongue and other speech organs which give rise to each separate vowel. This we shall now do for consonants. And first let us recur to what we have just alluded to above, namely the distinction between the consonants which we called "explosives" and those which we called "continuants." This distinction, it will be noticed, is not dependent on the *position* of the vocal organs, but on their *action*. Thus the tongue is very nearly in the same position for each of the consonants *t* and *s*, and the wide difference between them is due to the fact that one is produced by a sudden explosion, the other by a continuous expulsion of breath. We further called attention above to a class of consonants which we named "trills." And here again it will be seen that the essential characteristic of the trill is not due to the position of the tongue, but to the way it behaves when in that position. Thus, to pronounce the first letter in *rub*, as it would be pronounced in Scotland, the tongue has to be placed in the same position as for the first letter in *dub*. But in the former case the tongue trills rapidly up against the palate, while in the latter it merely touches the palate once to produce the whole sound of the consonant.

Finally, there is a whole class of consonants formed by allowing the breath, or part of it, to pass through the nose instead of through the mouth. This is a subject of which we have already more than once postponed the consideration, but at the stage we have now reached only a few words are necessary to enable the student to understand it.

NASAL SOUNDS.

Right at the back of the mouth is a piece of tissue that forms as it were a continuation of the palate, but is unattached at one end, and in ordinary breathing hangs loosely down and allows the breath to pass out either through the nose or through the mouth. This piece of hanging tissue is called the uvula, and its function is to act as a valve between the mouth and nostrils. For, by pressing the uvula back against the passage to the nostrils, the whole of the breath can be compelled to pass out through the mouth. And this is what happens with all the consonants and vowels about which we have already written. But in the formation of certain sounds called "nasal," the uvula is allowed to hang loosely, so that some of the breath passes through the nose. Thus, for example, *m* is a nasal consonant. To produce it, all that is necessary is to place the lips in the position for forming the sound *b*, and allow some of the breath to escape through the nose. To verify this, pronounce the words *baa* and *maa* carefully and repeatedly in front of a looking-glass. It will be seen that the lips do not alter their position in the slightest, and after a little while the experimenter will be able to detect by his own sensations that the difference in the sounds is due to the breath passing down his nose when he says *maa*, and only through his mouth when he says *baa*. Other nasal

sounds in English are the consonants represented by *n* and *ng*, but in many foreign languages nasal vowels are common. It ought, however, to be remarked here that the French nasals represented by *an* (or *en*), *on*, *in*, *un*, are not formed simply by nasalising the corresponding pure vowels, but are accompanied with a slight contraction of the guttural passage, which gives them a distinct character. The student who is familiar with French can test this by saying *a* as pronounced in *father*, and then trying to pass to the French *an*. He will find that not only is the breath expelled through the nose, but also that there is a perceptible compression at the top of his throat. Besides these intended nasals, many speakers of English, especially Americans, unintentionally pronounce all their vowels with a nasal twang. This is due to imperfect closing of the nasal passage.

CLASSIFICATION OF CONSONANTS.

And now to return to our task of classifying consonant sounds. We have already enumerated four distinct categories of consonants which depend on distinct actions of the organs of speech. They are (1) explosives, such as *p*, *t*, *k*; (2) continuants, such as *f*, *s*, *sh*; (3) trills, represented in English by *r* and *l*; (4) nasals such as *m* and *n*. But beyond and above these categories is that broad distinction which we emphasised so fully at the beginning of these chapters, namely the distinction between voiced and voiceless sounds. So that if we wished to make a rough preliminary table of specimen consonant sounds, it ought to take somewhat the following form:—

	Explosives.	Continuants.	Trills.	Nasals.
Voiced . .	b d	v z	l r	m n
Voiceless .	p t	f s	ll (Welsh).	

This table is complete so far as classification depending on the *action* of the speech organs is concerned. What we have now to do is to show how the above groups of sounds ought to be subdivided into classes depending on the *position* of the speech organs. Thus, for example, take the two voiceless explosives *p* and *t*. How are these sounds formed? The student must answer the question for himself. In pronouncing *p* he will feel that his lips only come into play, while in the case of *t* the lips are not employed at all, but the sound is produced by the point of the tongue striking the forward part of the palate. We might, therefore, if we liked, call *p* a "labial," and *t* a "palatal." Again, take the consonant *k*. This is also voiceless and explosive, and therefore comes in the same group as *p* and *t*. In what sub-class then shall we place it? Again the student must answer for himself. Notice that in saying *k*, the tongue is far back in the mouth so that the sound is formed almost in the throat. For this reason *k* is generally called a "guttural," and the term is so convenient and popular, that though not strictly accurate, it is best as a whole to adhere to it. Thus we have already sketched out three sub-classes of sounds.

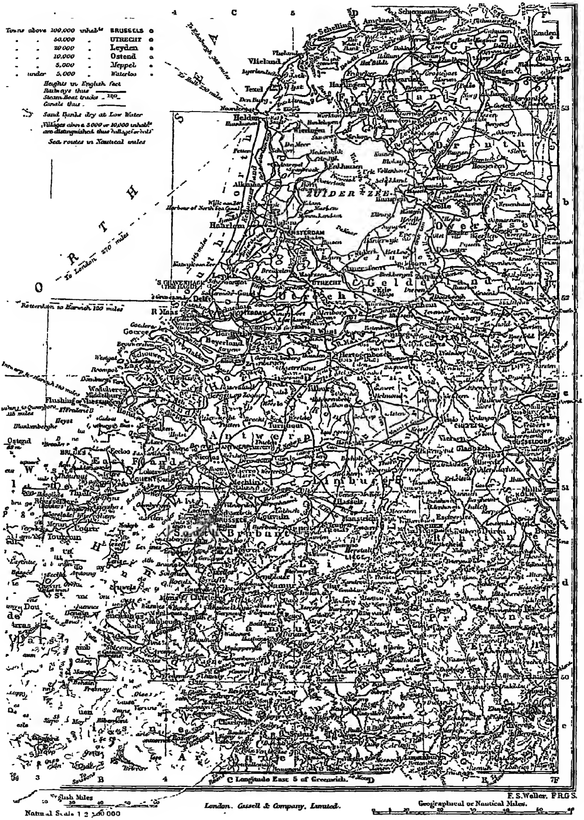
But we have not done yet. For if we now turn to the continuant sounds, we shall see that at least one more sub-class is necessary. In our table we have set down *s* as a voiceless continuant, and another consonant that falls into the same group is the *th* in *thin*. Let the student carefully pronounce the two words *sin* and *thin*, and then gradually drop the *in*, so as to pronounce only the initial consonant. He will notice that while with *s* the consonant is formed by allowing the tongue to rest against the palate, with *th*, on the other hand, the tongue rests against the teeth, almost protruding between them. Thus for *th* no name would be so appropriate as "dental." As to *s*, we have already found a name for it, for if the student will carefully pronounce first *t* and then *s*, he will notice that the tongue is almost in exactly the same position in each case, so that *s* like *t* is a palatal.

It will perhaps be useful here, by way of parenthesis, to call the reader's attention to the frequent confusion that is made between the palatal *s* and the dental *th*. This confusion is easy because both sounds are in the same group of "voiceless continuants," and only differ from one another in the position of the tongue. Hence we find that little children often say "sink" for "think," while babies of a larger growth affectedly lisp out *thweet* when they mean *sweet*.

Let us now again take stock of our position. We have arrived at this point, that *k* may be called a guttural, *s* and *t* palatals, *th* a dental, and *p* a labial. But this would be very useless knowledge unless we showed that these names represented classes of sounds and not merely individual consonants. So that before extending our nomenclature any farther, let us see what is included under the names we have already given.

GUTTURALS.

And to begin with the first-named class, what other gutturals do we know of besides *k*? Obviously *g* in *give* is also a guttural, for it differs from *k* only in being voiced. Again, the consonant sound represented by *ng* in *thing* and by *n* alone in *think* and in *finger*, is a guttural. It is also a nasal—a



Towns above 100,000 inhabts BRUSSELS
50,000 UTRECHT
20,000 Leyden
10,000 Ostend
5,000 Meppel
under 5,000 Waterloo
Heights in English feet
Railways thus
Steam Boat tracks 120
Canals thus
Sand Banks dry at Low Water
Villages above 5,000 or 10,000 inhabts are distinguished thus Villages
Sea routes in Nautical miles
N O R T H S E A
To London 270 miles
Rotterdam to Harwich 120 miles
To Hull 230 miles
ZUIDER ZEE
AMSTERDAM
UTRECHT
BRUSSELS
ANTWERP
GHENT
LIEGE
Vlieland
Texel
Helder
Haarlem
Leyden
Delft
Flushing
Ostend
Namur
Maastricht
Arnheim
Nijmegen
Zwolle
Groningen
Emden
C Longitude East 5 of Greenwich
English Miles
Natural Scale 1 2 500 000
London. Cassell & Company, Limited.
F. S. Weller, F.R.G.S.
Geographical or Nautical Miles.

fact which the student can verify for himself by pinching his nose and trying to say *ing* at the same time. He will then feel the breath struggling to escape through his nostrils, while no similar inconvenience will be experienced with the non-nasal sound *g*. In the same way the student can verify that *ng* is a voiced consonant by placing his finger on his throat, when he will feel the vibration of the vocal chords while he produces the word *ing*. Thus the sound generally represented in English and in German by *ng* would be fully described as a voiced nasal guttural consonant.

So far, then, we have found two explosive gutturals and one nasal guttural. We now pass on to guttural trills, and to guttural continuants. With regard to the former the best example is the French *r* grasseyé, which might be represented by *ghr*, and as to the latter we have excellent examples in the Scotch *loch* and the German *ach*, and for the corresponding voiced sound in the German *Tag*. Supposing that, by analogy with *k* and *g*, we were to represent these two sounds by *kh* and *gh*, we should then be able to exhibit a little table of gutturals somewhat in the following form:—

	Explosives.	Continuants.	Trills.	Nasals.
Voiced - -	g	gh	ghr	ng
Voiceless -	k	kh		

If we extend our view of speech sounds to extra-European languages, we might add to these gutturals a series of back-gutturals that occur in Arabic, Persian, and Hindustani. Thus we have first the back guttural explosive *qâf* corresponding exactly to the English *k*, but farther back in the throat. This is the initial consonant in the word *Koran* or *Coran*, which, according to the official spelling of the Indian Government, should be written *Qur'án*. Secondly, we have the back-guttural continuants represented in Indian spelling by *gh* and *kh*, but farther back in the throat than the analogous German sounds.

CHEMISTRY.—XI.

[*Continued from p. 5*]

CALCIUM—STRONTIUM—BARIUM—ALUMINIUM—MAGNESIUM—ZINC—CADMIUM.

Calcium Carbonate, $CaCO_3$, occurs as chalk, limestone, marble, and crystalline, as calcite or Iceland spar. Most shells, egg-shells, corals, etc., contain much calcium carbonate.

The volatile salts of calcium colour the Bunsen flame orange-red. In solution they give a white precipitate with ammonium carbonate in the presence of ammonium hydrate and ammonium chloride, but give no precipitate with a solution of calcium sulphate.

Strontium, Sr, atomic weight, 87·5.—This is a yellowish metal resembling calcium. It occurs, like calcium and barium, as the carbonate "strontianite" and the sulphate "celestine"; it derives its name from Strontian in Argyllshire, where its compounds were first discovered. The salts closely resemble those of calcium and barium; they are but little used in the arts.

Strontium Nitrate, $Sr(NO_3)_2$, is a colourless crystalline salt, prepared by dissolving the carbonate in dilute nitric acid and evaporating the solution; it is much used for fireworks.

All volatile strontium compounds give a magnificent crimson colour to the Bunsen flame. Its spectrum exhibits eight lines, two very bright—one in the orange and one in the blue—one fairly bright in the red, and five less bright in the red. (*See* Coloured Plate, Frontis., Vol. IV.) In solution the salts give a white precipitate with ammonium carbonate in the presence of ammonium hydrate and ammonium chloride, and a white precipitate with calcium sulphate solution on boiling or after long standing.

Barium, Ba, atomic weight, 137.—This metal also occurs in nature as the sulphate $BaSO_4$, "barytes or heavy spar," and the carbonate $BaCO_3$, "witherite."

Barium Oxide, BaO, is prepared usually by heating the nitrate $Ba(NO_3)_2$; it resembles calcium oxide, and combines with water, evolving great heat, forming a crystalline barium hydrate, $Ba(HO)_2 + 8H_2O$, which is much more soluble in water than the corresponding strontium and calcium compounds.

Barium Chloride, $BaCl_2$, is a colourless crystalline salt formed by dissolving barium carbonate in dilute hydrochloric acid and evaporating the solution.

Barium Nitrate $Ba(NO_3)_2$ is obtained by dissolving the carbonate in dilute nitric acid and evaporating the solution.

All soluble sulphates give with barium salts a white precipitate, insoluble in hydrochloric acid.

Barium Sulphate, $BaSO_4$, barytes or heavy spar.—This is one of the most insoluble substances known, one part requiring 400,000 parts of water to dissolve it. It is sometimes used as a white pigment, and to adulterate white lead. All the soluble barium salts are poisonous, the antidotes being either sodium sulphate or magnesium sulphate (Epsom salts), which precipitate the barium as insoluble barium sulphate.

All the volatile barium salts give a yellowish-

green colour to the Bunsen flame. In solution they give a white precipitate with ammonium hydrate, ammonium chloride, and ammonium carbonate, and an immediate white precipitate with calcium sulphate in the *cold*.

Aluminium, Al, atomic weight. 27·5, specific gravity, 2·5.—This white metal does not occur native, but is found widely distributed as the oxide, alumina, Al_2O_3, and the silicate, clay, and in many other minerals.

Aluminium is usually prepared either from a mineral "bauxite," which is a hydrate of aluminium containing iron, silica, etc.; or from "cryolite," a double fluoride of sodium and aluminium. In the manufacture of aluminium as at present carried out by the Alliance Company, the cryolite is melted, and then masses of sodium are pushed down by iron rods into the melted cryolite; a violent reaction ensues, the aluminium is reduced and forms a melted mass under the fused sodium fluoride—

$$3Na + \underbrace{3NaF, AlF_3}_{\text{Cryolite.}} = 6NaF + Al.$$

If bauxite, $(AlFe)_2O_3 + 2H_2O$, be used, it is first fused with sodium carbonate, when the alumina is converted into sodium aluminate, $Na_2Al_2O_4$, which is dissolved out by water, the hydrate of iron remaining behind undissolved. Carbon dioxide is then passed through the decanted solution, and the aluminium precipitated as aluminium hydrate, $Al_2(HO)_6$. This precipitate is collected mixed with salt and carbon, formed into balls, and dried. These balls are made white-hot, and while hot, chlorine is passed over them—

$$Al_2O_3 + 2NaCl + 3C + 6Cl = \underbrace{Al_2Cl_6 2NaCl}_{\text{Double chloride of sodium and aluminium.}} + 3CO;$$

the double chloride of sodium and aluminium is converted by the high temperature into a vapour, which is condensed in suitable chambers; finally, this double chloride is heated with metallic sodium—

$$Al_2Cl_6 2NaCl + 6Na = 2Al + 8NaCl.$$

A process has also been recently worked by Cowles in which a mixture of alumina, Al_2O_3, charcoal, and some metal, *e.g.*, copper, is heated in a special furnace to a very high temperature by passing a very powerful current of electricity; under these conditions metallic aluminium is formed, and alloys with the copper. Aluminium is a tin-white metal which takes a fine polish. Its special feature is its extreme lightness when compared with other metals; thus, lead is about five times, silver four times, copper three and a half, and iron, tin, and zinc about three times as heavy as aluminium. It is said to be an excellent conductor of electricity; it tarnishes but little in the air; nitric acid has no action upon it, but it is soluble in hydrochloric and dilute sulphuric acids, also in caustic potash solution. It is not tarnished by sulphur or sulphides; it cannot be used for cooking purposes, because it dissolves in a solution of common salt when organic acids (acetic, tartaric, etc.) are present. It has long been hoped that its lightness and its colour might be largely utilised in the arts and manufactures, but its price (15s. to 20s. per lb.) seems at present somewhat prohibitive. It is used for scientific instruments, balance beams, weights, telescopes, opera-glasses, etc. It is very malleable and sonorous; there is considerable difficulty in soldering it. It forms with copper a most beautiful alloy, *aluminium bronze*, which seems to be a true chemical compound, Cu_9Al, and has the colour of 15-carat gold; it is said to have the strength of cast steel, while it has the great advantage of not rusting when exposed to the air.

Alumina, Al_2O_3.—This occurs in nature almost pure as the ruby, coloured red by chromium; the sapphire, coloured blue by cobalt; and the Oriental emerald; and in an impure form as corundum, emery, etc.; when crystallised, as in the ruby, sapphire, emery, etc., its hardness is only exceeded by that of the diamond, and so emery is much used for cutting and polishing other precious stones, glass, steel, etc.

Aluminium Hydrate, $Al_2(HO)_6$, is obtained as a gelatinous precipitate by adding ammonium hydrate to a solution of ordinary alum; this substance has a marked power of combining with various colouring matters, and precipitating them from their solutions as coloured precipitates termed "lakes." Many of the aluminium compounds are therefore used as "mordants," *i.e.*, bodies which cause the colouring matter to "bite into" the fabric, and thus make the dye "fast"—that is, not liable to wash out.

Aluminium Sulphate, $Al_2(SO_4)_3$, is prepared on the large scale by dissolving heated clay in strong sulphuric acid in leaden dishes. Its solution is used as a mordant.

Alums.—Ordinary alum is a double sulphate of aluminium and potassium, $(Al_2(SO_4)_3 + K_2SO_4 + 24H_2O)$, or ammonium, which crystallises with twenty-four molecules of water of crystallisation, generally in octahedral crystals. The term alum is now extended to all substances having a similar constitution. Thus we have alums containing no aluminium, as chrome alum, $Cr_2(SO_4)_3 + K_2SO_4 + 24H_2O$, and iron alum, $Fe_2(SO_4)_3 + K_2SO_4 + 24H_2O$. In this country alum has been made at Whitby and other places from a hardened clay or shale containing finely divided iron pyrites, FeS_2. This shale is

broken up, and either heated in air or exposed in heaps to the action of the atmosphere; in either case the iron pyrites is oxidised—

$$FeS_2 + 7O + H_2O = FeSO_4 + H_2SO_4.$$

The sulphuric acid thus produced acts on the clay, forming aluminium sulphate, which is extracted with water; a solution of potassium or ammonium sulphate or chloride is added when the alum crystallises out. Alum is largely used in dyeing; as a mordant it is particularly valuable because it is free from iron, which deadens many colours.

Soluble salts of aluminium give a semitransparent gelatinous precipitate of aluminium hydrate when treated with ammonium hydrate and ammonium chloride. When a solid aluminium compound is heated on charcoal with the blowpipe, it leaves a residue which glows brightly in the flame; if this residue be moistened with cobalt nitrate and reheated, a bright blue mass is obtained.

MAGNESIUM, ZINC, AND CADMIUM.

These metals have several properties in common. They are white or bluish-white and volatile; they all burn readily when heated in oxygen, forming one oxide, which is insoluble in water. Their oxides and hydrates are readily soluble in ammonium salts; the chlorides are volatile and deliquescent; the sulphates crystallise with seven molecules of water of crystallisation. They are all dyad elements replacing two atoms of hydrogen.

Magnesium (Mg), atomic weight 24, specific gravity 1·74. This metal in some respects resembles those of the alkaline earths; it was first observed in 1695 as its sulphate, the well-known "Epsom salt"; it also occurs largely as carbonate, especially when mixed with calcium carbonate, forming the building-stone "dolomite" or magnesian limestone $(MgCa)CO_3$, of which the Houses of Parliament, etc., are built.

Magnesium is a light, white, soft, malleable metal, which, when heated in the air, burns with an intense white light, forming a cloud of magnesia, MgO; the light is very brilliant, and has been used in photography. A most convenient device is to blow a small quantity of the finely powdered metal through a spirit-lamp flame ("flash light"). Magnesium is prepared by heating solid magnesium chloride with metallic sodium, some fluorspar being added to protect the heated metal from the action of the air. Magnesium does not decompose water at 100° Cent., but dissolves readily in acids.

Magnesium Oxide, magnesia (MgO). This substance is usually obtained as a white infusible powder by igniting the carbonate (magnesia alba), hence it is termed "calcined magnesia." It is almost insoluble in water.

Magnesium Chloride ($MgCl_2$). This salt is prepared as a deliquescent solid by dissolving magnesium oxide in hydrochloric acid, adding ammonium chloride, evaporating to dryness and heating the residue to 450° Cent. It has a great affinity for water, and so always keeps moist if exposed to the air (deliquescent).

Magnesium Sulphate ($MgSO_4 + 7H_2O$), Epsom salt, occurs in colourless crystals, having a bitter taste; it is much used as a purgative. It is found in the potash mines at Stassfurt.

Magnesium salts in solution give no precipitate with ammonium hydrate, ammonium chloride, and ammonium carbonate (difference from Ca, Sr, Ba), but are precipitated on the addition of sodium phosphate. When heated on charcoal, they leave a residue which glows brightly. They give no colour to the Bunsen flame.

Zinc (Zn), atomic weight 65, specific gravity 6·9, is a bluish-white metal. It occurs as the red oxide, ZnO, in America, etc.; as calamine or zinc carbonate, $ZnCO_3$, in Belgium, Spain, etc.; as the silicate, $Zn_2SiO_4 + H_2O$, and the sulphide or blende, ZnS. The ore is first roasted and thus converted into oxide; this is mixed with coal, and the mixture heated when the zinc oxide is reduced, $ZnO + C = Zn + CO$, and the zinc being converted into vapour distils over and is collected. Cast zinc is termed "spelter" (a name also given to a fusible brass used for brazing). Zinc when heated burns with a greenish flame, forming voluminous white flocks of zinc oxide (philosopher's wool). Zinc is easily soluble in hydrochloric, sulphuric, and nitric acids. It oxidises but little in the air if kept free from acid. It is much used on account of its cheapness and lightness for roofing, etc.; much is also used for "galvanising" iron pipes, cisterns, etc. The iron is first cleaned and then dipped with certain precautions into melted zinc; the zinc adheres to the iron and forms an excellent protective coating. Large quantities of zinc are used for making brass, an alloy of two parts of copper and one of zinc. Zinc can only be rolled when heated to about 150° Cent.

Zinc Oxide (ZnO) is a white powder which turns yellow when heated, regaining its whiteness on cooling; it is sometimes used as a white paint, as it is not turned black by sulphur compounds.

Zinc Chloride ($ZnCl_2$) is prepared by passing chlorine over heated zinc, or by dissolving the metal in hydrochloric acid and carefully evaporating the solution; it is a white deliquescent solid. It is very poisonous. Its solution is known as Burnett's disinfecting fluid. Its disinfecting action is due to its power of coagulating albumen, and thus preventing its liquefaction, which is the first stage of

putrefaction; to its poisonous nature, killing germs, fungi, etc., which set up the putrefactive process; and lastly, to its power of absorbing some of the products of putrefaction, as ammonia, hydrogen sulphide, etc. Another very important though humble use is made of this substance by the tinker; when a strong solution is applied to copper, brass, iron, etc., it promotes in a wonderful way the adhesion of the melted solder (an alloy of tin and lead). The best antidotes in cases of poisoning are milk, beaten-up white of egg, or largely diluted solutions of sodium carbonate.

Zinc Sulphate, white vitriol ($ZnSO_4 + 7H_2O$). This is a white crystalline substance, usually prepared by carefully roasting blende, ZnS, and extracting the roasted mass with water. It forms one of the safest and most useful of emetics in cases of poisoning, etc. The dose is 20 grains dissolved in much warm water.

Zinc salts when heated on charcoal leave a residue which glows in the blowpipe flame; if the residue be moistened with a few drops of a solution of cobalt nitrate and reheated, a bright green mass is obtained. Zinc salts in solution give with ammonium hydrate and ammonium sulphide a white precipitate of zinc sulphide.

Cadmium (Cd), atomic weight, 112, specific gravity, 8·7. This metal closely resembles zinc in its general properties; it is, however, whiter and more volatile. Its compounds are but little used with the exception of its sulphide, CdS, which is a brilliant yellow, and is much used by artists; it is particularly valuable because it is not blackened by sulphur compounds. This metal enters into the composition of a most useful fusible alloy, Wood's metal, which contains four parts by weight of bismuth, two of lead, one of tin, and one of cadmium. This alloy is hard and white, but melts at about 61° Cent.

LATIN.—XXVI.

[Continued from p. 9.]

THE PERIOD: PARTICIPLES (*continued*).

§ 39. THE uses of the participles in Latin should be particularly observed, with a view to their adoption in the period; but the subjoined short sentences (all of which are to be rendered by the participial construction) will give the student useful practice and familiarity with the usage:—

Against your will, I came upon him while he was writing. When they had caught us, they loaded us with chains. After saying this, he went away. He surprised them in the middle of dinner. The news reached me as I was writing. On receiving this answer, we decided to remain. Followed by the cheers of a crowd, they left the city. Men who have been condemned should never be reinstated. The names of those who had the citizenship presented to them were cut upon a board. They stood still, in amazement, at the miraculous sight of men breathing out flames. Trajan on his death-bed gave these instructions. Few people are ready to help up their enemy when he is down. Poverty surrounded them from the moment of their birth. All these things guarantee the invincibility of the Roman empire. The appointment of a dictator at Rome inspired terror in the minds even of the enemy. You love your friends even after they are dead. I say nothing of the levity of men who agree without reflection. On my starting for the camp, they told me that. When he had spoken, he saw he was wrong. He took up the crown again after throwing it away. He will not be persuaded except by being punished. Shouts of indignation rang through the whole of the senate-house. As long as you follow him, you will never go wrong. It was through fear of her father that she did the deed. He began the battle against the consul's expressed opinion. He conquered without the inducement of any reward or the help of a single friend. Although he had succeeded in nothing, he expected to be praised. After crushing the pirates, he received an ovation. The remains of the men who had been slain in the defeat of Varus were buried in a single grave. That is the thought of a madman. After being often conquered, men surrender in despair of victory. When I asked him who was there, he made no reply.

§ 40. After this much practice in the use of the Latin participles, it will be easy to employ them—where needful—in the following passages, in the translation of which the student will choose the periodic or the detached style, in accordance with the varied character of the narrative in either piece. The hints and notes to § 36 should also be read over again.

(1) He met Clodius in front of his country-house at about eleven o'clock, or not far from it, and a body of men, armed with swords, instantly made a rush upon him from the higher ground, and set upon and killed the driver. Milo flung off his wraps, and jumped down from the carriage, and began to defend himself with vigour. Thereupon, the men with Clodius pulled out their swords, and some of them ran back to the carriage to attack Milo from behind; while others, thinking he was as good as dead, began to kill his servants who were in the rear. They were faithful to their master and ready to help him. Some, however,

were cut down in a moment. The others saw a struggle going on around the carriage, but were prevented from giving their master any assistance. So when Clodius with his own mouth told them that Milo was killed, and they believed it really was the case, then these servants of Milo, with no master at hand to give them orders, or to know what they did, did just the thing which every one of us would have wished his servants to have done in such an emergency. I do not say this with the object of diverting the charge, but simply to state the facts of the case.

(2) Both sides cheered, and the cheer was taken up and answered from the earthwork and all the entrenchments. The English, having fired a volley, charged with the bayonet. Suddenly the cavalry came into sight in the rear; and the other battalions coming up at the same time, the French began to give ground and flee, but the cavalry intercepted them in the act and inflicted great loss upon them. One of their generals—Louis, the Duke of Aquitaine—was killed; the Prince of Auvergne was taken prisoner as he was trying to escape; and some fifty standards were laid at Richard's feet. Out of all that host, a mere handful only made their way back to the camp alive. Meanwhile, their allies in the town, when they saw the slaughter and rout of their men, thinking their case hopeless, withdrew their garrison from the entrenchments; and no sooner did intelligence of this net reach the French, than they fled in panic from the camp; and if the English had not been worn out by the incessant sallies they had had to make, and by the whole day's work, they might have exterminated the enemy. As it was, large numbers were taken prisoners and killed by the cavalry, who were despatched about midnight, and overtook the rear of their column. Those who survived the flight betook themselves to their own villages.

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§ 41. Different Styles of Prose. Historical Prose.

So far, we have been considering the characteristics general to all Latin Prose; but different styles are, of course, appropriate for different subjects; in the principles we have laid down we had mainly in view the historical style, or the style of ordinary written narrative. Such a style of prose admits of longer and more elaborate sentences, and more artistic grouping of them, and, generally, is privileged to make a greater demand upon the attention, than a style primarily addressed rather to the ear than to the eye is permitted to make. One can think between the lines while reading, or even re-read a passage, though, of course, a writer would be unwise to presume too much upon the willingness of his readers to repeat this process often. The developed historical Latin style is, accordingly, much more elaborate, varied, and—in some writers—condensed in expression, than the other prose styles which are regulated by the requirements of speech or conversation.

If we are to have at all a complete view of the structure of Latin Prose, we ought, therefore, in conclusion, to notice also the chief characteristics of the other styles which were employed by the Romans—the Oratorical, Philosophical, and Epistolary styles.

§ 42. Oratorical Prose.

Most of the Latin speeches that have come down to us are carefully revised editions of the speeches that were actually delivered, and not a few were never delivered at all; but they show clearly what were the characteristics of Roman oratory. The aim was naturally always to arrest attention and to please the ear; to win a hearing and to keep it; to secure clearness and simplicity and to tax the efforts neither of speaker nor of audience. Short, well-balanced, and rhythmical sentences, fluent and easy to follow, and repetitions of words and of similar thoughts and expressions, are frequently found in the oratorical style. The persons referred to are not simply alluded to in the third person; they are apostrophised, directly addressed by name, even though they are not present. Such circumlocutions as "the honourable member" are unknown to Latin oratory; the second personal pronoun and the vocative of the proper name take their place. Explanations and interrogations are constantly employed in order to attract attention in cases where English uses the tame and colourless simple statement. Such personal appeals and protestations should be introduced as largely as possible. The use of these rhetorical devices, and of exclamations, helps to drive home the thought and to emphasise the sense. Similarly, a sharp and startling effect is produced by asyndeton (the omission of the usual co-ordinating conjunctions or the failure to repeat the interrogative, relative, or adverbial conjunction) in passages of energetic and excited feeling, just as, on the other hand, the quieter emotions would be represented by pleonastic expressions and expansions of the same words or thoughts.

Such oratorical figures are, of course, to be commonly found in English speeches, but they were adopted to a much greater extent by the Latin orators, all of whom had passed through

that elaborate training in rhetoric which constituted a most important element in the education of every Roman of high rank. The rhetorical tendency thus fostered and developed (many traces of which, as we have noticed, are stamped upon their language and whole mode of expression), naturally found free play and wide scope in the law-courts and the senate.

§ 43. The following speech may be taken as a fair sample of English oratorical style; and with the characteristics of Latin oratory before us, and the aid of the notes appended on special constitutional points, there will be little difficulty in securing an idiomatic and characteristic Latin rendering:—

Even if he had not effectually cut himself off from the sympathy of this House[1] by his wanton attacks upon its members, what service has he ever rendered of sufficient importance to make it necessary for him to send to the Government[1] news of his success? He will hardly point to the disturbances in India, the shameful loss of towns, the devastation of district after district, the annihilation of our army by war and famine and plague! Why! the man has never sent home a despatch of any kind! In his public life in England, he showed himself more unprincipled than his friend, the honourable member opposite.[2] He has proved himself in his government abroad scarcely one whit less assuming. His friend, a very sink of greed,[3] whose guiding motive is neither fame nor glory, but mere appetite, ruined the merchants[4] of England by his government; and with that fine army of his, accomplished nothing but the devastation of cities, the ruin of countries, the impoverisation of homes! And then he had the audacity to address a despatch to His Majesty's Ministers[1] claiming a vote[5] of thanks! Indeed, his audacity knows no bounds. And it is the friend of such a man—good heavens!—he and his friend, the pair of them (the Scylla and Charybdis of our country)—who are trying to disparage me, while they magnify themselves. To disparage me, I say, in whose support during my absence abroad such public meetings were held, such resolutions of Parliament[1] passed; aye! and of town councils, and companies, and clergy[6]—in a word, of all ranks and conditions of men—far beyond my desires and even my dreams! while, on the other hand, both of them have incurred a stigma of infamy[7] that can never be removed!

NOTES.

[1] During the best period of the Roman Republic, the Senate practically controlled all foreign policy, and formed the supreme deliberative assembly and executive government (*curia, senatus, ordo senatorius*, etc.).

[2] Remember the Roman directness, and make it throughout a personal attack upon an opponent regarded as present really or in imagination.

[3] On the whole, Latin uses metaphors (even such as it had) far less than English; it prefers to express the whole simile. But metaphorical personifications of a very strong kind are common in the oratorical style. So here such words as *ille gurges, vorago, heluo*, may be employed.

[4] The "*equites*" were the great capitalists and merchants of Rome.

[5] The nearest Latin equivalent would be the *supplicatio*, which was decreed both after victories ("day of thanksgiving") and also after great calamities ("day of humiliation").

[6] At Rome there was no class of men who occupied a position corresponding to that of the "clergy" in modern society. "At Rome, the Duke of Wellington might also have been Archbishop of Canterbury" is an epigrammatic expression of the union of civil or military and religious offices which prevailed. The priests, augurs, etc., were, however, united in guilds or brotherhoods (*collegia*), and so we may represent the idea sufficiently nearly by the word *collegia*.

[7] *Vide* dictionary under *censor, nota, ignominia*.

VERGIL.—II.

The first book of the "Æneid" goes on to relate how Juno, jealous of the Trojans, induced Æolus, king of the winds, to send a storm against the fleet of Æneas. The Trojan ships are tossed and scattered; but Neptune, angry at the disturbance in his realms, quells the tempest, and most of the ships find their way to a peaceful harbour on the coast of Africa.

Meanwhile Venus, the guardian deity of Æneas, has complained to Jupiter of the cruel designs of Juno. The lord of heaven promises a happy fortune to the Trojans. Æneas, he says—

> "Bellum ingens geret Italia, populosque feroces
> Contundet; moresque viris et moenia ponet."

"He will wage a mighty war in Italy, and will crush the fierce peoples; he will establish customs and found walls for his heroes."

To the Romans he has promised the empire of the world—

> "His ego nec metas rerum, nec tempora pono;
> Imperium sine fine dedi."

"I set no bounds of place or time to their power; I have granted them an empire without end."

Meanwhile, Æneas sets out with his trusty

comrade Achates to survey the shores on which he has been cast. Venus meets him, disguised as a huntress, and tells him that he is in the kingdom of Dido, who has fled from Tyre with her people (*dux femina facti*), and is now founding the mighty city of Carthage. Æneas and his companion come to a hill overlooking the city, and see the Tyrians at work:—

Jamque ascendebant collem, qui plurimus urbi
Imminet, adversasque aspectat desuper arces.
Miratur molem Aeneas, magalia quondam;
Miratur portas, strepitumque et strata viarum.
Instant ardentes Tyrii: pars ducere muros,
Molirique arcem, et manibus subvolvere saxa;
Pars optare locum tecto, et concludere sulco;
Jura magistratusque legunt, sanctumque senatum.
Qualis apes aestate nova per florea rura
Exercet sub sole labor, cum gentis adultos
Educunt fetus, aut cum liquentia mella
Stipant, et dulci distendunt nectare cellas;
Aut onera accipiunt venientum, aut agmine facto
Ignavum fucos pecus a praesepibus arcent:
Fervet opus, redolentque thymo fragrantia mella.
"O fortunati, quorum jam moenia surgunt!"
Aeneas ait, et fastigia suspicit urbis.

. . . .

Hic templum Junoni ingens Sidonia Dido
Condebat, donis opulentum et numine divae;
Hic primum in luco nova res oblata timorem
Leniit; hic primum Aeneas sperare salutem
Ausus, et afflictis melius confidere rebus.
Namque sub ingenti lustrat dum singula templo
Reginam opperiens, dum, quae fortuna sit urbi,
Miratur, videt Iliacas ex ordine pugnas,
Bellaque jam fama totum vulgata per orbem,
Atridas, Priamumque, et saevum ambobus Achillem.
Constitit et lacrimans, "Quis jam locus," inquit,
"Achate,
Quae regio in terris nostri non plena laboris?
En Priamus! Sunt hic etiam sua praemia laudi;
Sunt lacrimae rerum, et mentem mortalia tangunt,
Solve metus; feret haec aliquam tibi fama salutem."
Sic ait, atque animum pictura pascit inani.

NOTES.

1. *Qui plurimus.* Lit., "which most of it"—*i.e.*, "which in its great extent."

2. *Aspectat desuper.* "Looks at from above"—*i.e.*, "looks down on."

Arces. The fortified part of a city (tha citadel) was called the *arx* (l. 6); but *arces*, in the plural, is used for the fortifications generally (= "the towers").

3. *Magalia* = "huts." The word is of Phœnician origin, and we learn elsewhere that the suburbs of Carthage bore the name *magalia*.

4. *Strata viarum.* *Strata* (from *sterno*) is the neuter plural of the passive participle used as a substantive. The poets used adjectives and participles with a genitive dependent on them. *Cf.* Horace, *amara curarum* ("the bitterness of men's cares"). This = "the smooth (parts) of the streets"—*i.e.*, the level streets.

5. *Ardentes.* The metaphor of work "glowing hot" occurs also below, in l. 15 (*fervet opus*).

7. *Concludere sulco.* An allusion to the Italian custom of marking out the limits of a city (called *pomerium*) with a broad furrow.

8. *Legunt*, in the sense of choosing, is strictly appropriato only to *magistratus* and *senatum*. With *jura* wo must translate it "appoint."

9. *Qualis* This is an instance of the poet's use of similes. Vergil is fond of introducing a comparison in this way, and lets himself be carried away into details which are picturesque or effective in themselves, but not appropriate to the purpose of the simile. This is a beautiful picture of the bees' activity.

13. *Venientum.* This form of the genitive plural (in place of *venientium*) is used for metrical purposes.

Agmine facto. A term appropriate to the operations of an army is purposely used.

14. *A praesepibus.* "Stalls"—*i.e.*, "hives."

16. *Jam.* The emphasis is on this word. Æneas is thinking how long he has to wait for the walls of his own city to rise.

18. *Sidonia* = "Tyrian." Dido came from Tyre.

20. *Nova res oblata.* "A strange thing offering itself." We should say, "the occurrence of a strange thing" It is a Latin idiom to use a passive participle with a noun in agreement, instead of an abstract substantive with a genitive.

23. *Singula.* "All things, one by one." We should say, "every detail."

25. *Ex ordine*—i.e., "set out in order." We are to understand that the history of the Trojan war was represented in tapestry or painting on the walls of the temple.

27 *Atridas.* Agamemnon and Menelaus, with whom Achilles quarrelled concerning the disposal of the captives. This is the theme of the early books of the Iliad.

Priamum. Priam, King of Troy and father of Hector. The poet refers to his interview with Achilles, when Priam begged for the body of his son.

30. *Sua praemia laudi.* *Sua*, the possessive pronoun of the reflexive, here refers to *laudi*, which is the logical but not the grammatical object of the sentence. The phrase reminds us of our proverb, "Virtue is its own reward," but its application here is different.

31. *Sunt lacrimae rerum.* This is one of the most beautiful lines of poetry ever written. *Rerum* refers to men's doings and sufferings; *mortalia*, things that men do.

33. *Pictura inani.* The epithet implies that it was only a picture, and therefore could not satisfy the longings of Æneas' heart.

KEY TO EXERCISES.

(p. 5.)

Ex. § 35.—Omnium consensu ad P. Scipionem summum est imperium delatum. Quibus de summa rerum inter paucos consultantibus nuntiat[1] quidam ex nobilibus Hispanis nequicquam eos perditam spem fovere[2]; desperatam conploratamque esse victoriam; nobiles etiam juvenes quosdam, quorum principem[3] L. Metellum, mare ac naves spectare, ut domum transfugiant[4]; consilium igitur advocandum de eo censere. Negat consilii rem esse Scipio; audendum atque

agendum, non consultandum ait in tanto malo esse. Irent secum extemplo armati, qui salutem suam vellent.[2]

Pergit ire sequentibus paucis in tabernaculum Metelli, et cum concilium ibi juvenum de quibus allatum erat invenisset, stricto super capita consultantium gladio, "Ex mei animi sententia,"[6] inquit, "ut ego rem propositam non deseram, ita neque alium militem Romanum deserere patiar; si sciens fefellero, tum me, Juppiter optime maxime, domum, familiam, remque meam pessimo leto afficias. In haec verba, L. Metelle, jures[7] postulo, ceterique qui adestis. Qui non juraverit, in se hunc gladium strictum esse sciat."

Haud secus pavidi, quam si victorem Hannibalem cernerent, jurant omnes custodiendosque semet ipsos Scipioni tradunt.[1]

NOTES.

[1] The idiomatic historic present in narrative description.

[2] *Cling to*—Latin *fovere*.

[3] A case where the infinitive attraction in subordinate relative sentences in *Oratio Obliqua* (referred to in § 29 *supra*) may be employed. *Esse* is understood.

[4] Strictly should be past tense, *transfugerent*. The use of the present—which is really the tense the speaker would have used—brings the situation more vividly before us; and such exceptions to the normal mode of expression (viz., past tenses of the subjunctive in all subordinate clauses in *Oratio Obliqua*) are very common in the historians, as a result of their wish to create a vivid impression of the scene they are describing.

[5] *Salvam vellent*, without *esse* expressed. An extension of the usual mode of expression with "factitive" verbs, as they are styled—*i.e.*, verbs containing the idea of *making*, whether actually or only in thought or word: *e.g.*, Illum *dictatorem* creant, me *consulem* nominant, etc., where the second accusative is required in order to complete the sense, and is really a *predicate* in apposition. (Similarly, in the passive such verbs are of course followed by the nominative: *e.g.*, *Dictator* creatus est ille, ego *consul* nominatus sum.) In all such cases, the connecting infinitive *esse* is very rarely used. So: Me *salvum* volunt, meam salutem *salvam* volo.

[6] This was a form of oath current among the Romans (understand *juro*), not affecting the construction of the rest of the sentence, the verbs of which are accordingly in the future indicative. Compare the English "so help me God."

[7] *Jures.* The subjunctive directly dependent on *postulo* without *ut* being expressed, a survival of the earlier independent use (co-ordinate instead of subordinate) of the jussive subjunctive. In combination with verbs of demanding, persuading, etc. (*oro*, *hortor*, *suadeo*), and with *licet*, *velim*, *oportet*, and a few other such phrases, the subjunctive is usually found without the addition of *ut*.

(p. 7.)

Ex. § 37.—(1) Giscone propere necito quum pene exsanguem virum ostendisset, Hanno dextram tenens orat, ne inultam mortem patris, ne se ipsum inimicis ludibrio esse sinat. Tuum est, inquit, Gisco, si vir es, regnum; non eorum, qui alienis manibus pessimum facinus fecere. Erige te, deosque duces sequere, qui clarum hoc fore caput divino quondam circumfuso igni portenderunt. Nunc te illa coelestis excitet flamma. Nunc expergiscere vere. Qui sis, non unde natus sis, reputa. Si tua te subito consilia torpent, at tu mea sequere.

(2) Eodem anno Q. Fabius Maximus moritur, exactae aetatis; siquidem verum est, augurem amplius[1] sexaginta annos fuisse, quod[2] quidam auctores sunt. Vir certe fuit dignus tanto[3] cognomine, vel si novum ab eo inciperet. Superavit paternos honores, avitos aequavit. Pluribus victoriis et majoribus proeliis avus insignis Rullus: sed omnia aequare unus hostis Hannibal potest. Cautior tamen quam promptior[4] hic[5] habitus fuit: et sicut dubites, utrum ingenio cunctator fuerit, an quia ita bello quod tum gerebatur proprie aptum erat, sic nihil certius est quam unum hominem nobis cunctando rem restituisse, sicut Ennius ait. Augur in locum ejus inauguratus Q. Fabius Maximus, filius: in ejusdem locum pontifex (nam duo sacerdotia habuit) Servius Sulpicius Galba.

NOTES.

[1] *Amplius* and *plus* are thus added without disturbance to the construction of the temporal phrase.

[2] *Quod.* Understand *fuisse* = "a fact for which . . ."

[3] Such indefinite adjectives of quantity, magnitude, are idiomatically used in Latin with reference to some preceding phrase which gives them the special and particular force required.

[4] Where two adjectives are thus compared, one of which is in the comparative, the second is also, in Latin, usually in the comparative degree.

[5] Note the Latin use of such demonstrative adjectives, where we in English have to express the proper name.

HISTORIC SKETCHES, GENERAL.—VI.

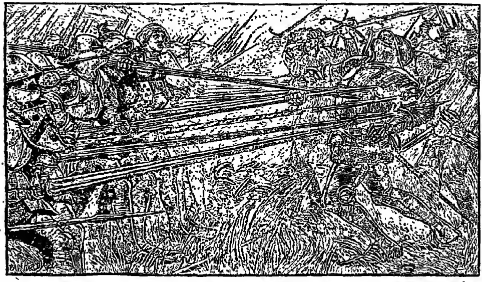
[*Continued from p. 13.*]

SWISS INDEPENDENCE.

One night in the spring of the year 1307, thirty-three men met in a field, known to this day as the Grütli meadow, on a spot overlooking the Swiss lake of the four cantons, and solemnly swore to assert the common cause of the liberties of the three cantons, Schweitz, Uri, and Unterwald, and yet "to do no wrong to the Counts of Hapsburg!" These men were but the representatives of thousands more, who, accustomed ever since human memory reported anything of the history of the country to share the freedom of the air they breathed, were moved to the very bottom of their hearts by the appearance of an oppression which threatened to go the length of enslaving them. What came of their vow thus made will be declared in this sketch; but let us first see what the circumstances were under which they felt constrained to bind themselves by the oath at all, and what claim the Counts of Hapsburg had to be so considerately treated in this purely non-aggressive sort of rebellion.

When, about the middle of the eleventh century, Europe in all its parts was beginning to settle down out of the confusion resulting from the overthrow of the western Roman Empire into a general state of feudalism, there was one country among the rest where the feudal conditions could not be enforced with the customary severity. That country was Switzerland. There was not found among the warrior chiefs who carved duchies, counties, and kingdoms for themselves out of the ruins of the Empire, one bold enough to try his hand at subjugating Switzerland for his own possession. The mountainous character of the ground, the utter absence of communication from place to place, except by paths dangerous to any but expert

climbers, the unattractiveness. unrichness of the land, and the stubborn, independent character of its inhabitants, suggested, to princes on the look-out, to go further afield, and no one pretended to feudal *régime*. In the towns also the spirit of freedom burned with considerable brilliancy, at least until the aristocratic element imparted by the country nobles invaded them; and even then there



WINKELRIED'S SACRIFICE.

claim rights of sovereignty there. The Emperor of Germany claimed a sort of supremacy over it, but he did not practically urge it, and the people, of whom the majority never heard of his pretension, went on without consulting him or troubling their heads about him. But though there was not any actual King of Switzerland, the country was included within the kingdom of Arles or Burgundy, and the Dukes of Burgundy—down to Charles the Bold—claimed lordship over it, a claim that was allowed to about the same extent as that of the Emperor was to be feudal lord paramount. In the country, however, there had established themselves many soldier chiefs, who built castles on their estates, and kept up some feudal rules, governing within their own domain almost as sovereign princes, but acknowledging for themselves allegiance to no one. Some of the ecclesiastical dignitaries came within this category. They had enormous estates belonging to their convents, and they governed as lords over such parts of God's inheritance as came under their power, though there existed at the same time in the breasts of the people a spirit of original independence which tempered the severity of the were found many hundreds of men who never bowed the knee save to God.

Chief among the lay nobles of the country were the Counts of Zahringen, Toggenburg, Kyburg, and Hapsburg; while their ecclesiastical rivals in power and influence were the Bishop of Coire, the Abbot of St. Gall, and the Abbess of Seckingen. Besides these, there were many lesser nobles who depended on the greater, or professed a sort of informal allegiance direct to the imperial crown; but all of these, the greater and the less, had been wise in time, and had at their own solicitation become "citizens" of some one or other of the towns, which in return often conferred upon them the honour and title of their "advocate" or protector. The religious houses adopted the like method to obtain the protecting services of some great noble. The existence of the "noble" class on the basis mentioned above was not found to be inconsistent with the existence of a purely democratic class in the towns. On the contrary, the modified character of the aristocracy, the community of interests between it and the democracy, proved to be a source of strength to both parties, and a strong love of country, which was common to both classes.

prevented that strength ever being used in the wrong direction. By degrees the wealthier townsmen assumed the rank, though not the title, of nobles, and extended yet farther the element of democratic aristocracy. Switzerland was not, however, a united country in the sense of being one dominion: it was not governed by any one set of laws, nor bound together by any formal ties or treaties; each town, each village, each noble, was self-governing and independent; the bond which knitted the several parts into a whole was the natural bond of necessity, which operated without any prescribed form.

The Counts of Hapsburg were the most considerable of the Swiss nobles, and by virtue of their rank were appointed "advocates" of many religious houses. They possessed large estates themselves, not only in Switzerland but on the Rhine also, so that what with their own property and that which they held in trust for the convents, they wielded a formidable influence either for good or evil. For many years this influence had never been used but for the furtherance of Swiss prosperity, and the people having learnt to love their strong counts, placed themselves to some extent in their hands; or to speak more precisely, the people of Schweitz and of part of Unterwald had made them their "advocates," an office which necessarily bestowed upon them the right to interfere in the administration of affairs, though it did not convey any proprietary or sovereign right.

Rudolph of Hapsburg had carried the fortunes of his family to their maximum height, and was possessed unquestionably of the ascendancy in Switzerland, when he was chosen by the electors to fill the vacant throne of the Empire. This was in the year 1273. It so happened that at this time the right of succession to the Duchy of Austria, with several other valuable political fees, became free for disposal, and the new Emperor, with the consent of the other princes of the Empire, gave the Duchy of Austria to his own son Albert.

Duke Albert was, for some reason or other which appears to have been warranted by facts, hated by the Swiss. He was insolent, overbearing, and disposed to plume himself upon his family grandeur and his wealth rather than upon his Swiss nationality. The Swiss held him to be *not* their friend, and it was with lively concern that they saw him about to succeed to his father's Swiss estates while he lived in his new duchy, uncontrolled by residence among his countrymen, and powerful to do them harm by means of his German subjects. It was probably at his suggestion that the defunct claim of the Imperial Diet or Parliament to bind Switzerland by its laws was revived during Rudolph's tenure of the throne. Certain it is that after his own election* to the Empire, on the death of his father's successor, Adolphus of Nassau, he tried to assert the imperial supremacy over Switzerland as part of Germany, and, abusing the privileges which, as Count of Hapsburg and as "advocate" of certain convents, he possessed, he sent imperial commissioners into the valleys of Schweitz, Unterwald, and Uri, to administer criminal justice and to act as stewards on his own and the convents' behalf. These persons were not native Swiss, but Germans who had no sympathy with the people, who despised the simplicity of their life and manners, and who made no secret of their contempt for them generally.

It was not likely such men would get on with the free-minded, high-spirited, and dominion-hating mountaineers. They did the work with which they were charged, disagreeable as it was by its nature, with studied harshness and brutal indifference to the popular feelings; they set aside the customary laws of the district, and introduced their own, which they administered in the most tyrannical fashion. The people were required to perform acts of homage to the Counts of Hapsburg which would have been degrading to "villeins" born and bred to feudalism; they were made to yield obedience to commands which were an affront to their free understandings, and to contribute towards the expense of riveting the imperial yoke upon their own necks. It was under these circumstances that the meeting took place in the Grütli meadow, and that Stauffacher of Schweitz, Furst of Uri, and Melchthal of Unterwald, bound themselves and their friends by the simple, solemn oath to do themselves right and the Count of Hapsburg no wrong. The people of the three districts flew to arms, and, with an ease they little expected, considering the "tall talk" in which their oppressors indulged, drove the Emperor's bailiffs out of the country.

This unlooked-for success did not make them too confident. They knew the power and the malice of the Duke of Austria, and that he would be likely to bring the whole force of the Empire upon them. They immediately entered into a confederacy or union of the three cantons, by the terms of which each canton, whilst reserving its right of self-government, was bound to make common cause with the others whenever summoned to do so. They were the forest cantons, the hard, rugged, naturally independent districts, that first set an example of

* The Imperial dignity in Germany was elective, the principle of hereditary succession not being recognised. Generally a German was elected, but not always. Francis I. of France and Henry VIII. of England were both candidates in their time.

federation upon special, recognised conditions. Fortunately for them, their enemy, Count Albert, was soon afterwards assassinated by his nephew, so that they had leisure to consolidate their union. The prince who succeeded Albert on the imperial throne was not unfriendly to the Swiss; but Leopold of Austria, Albert's son, thinking to punish the "cowherds and dairymen" who had dared to rebel against his father, led a considerable body of troops into the forest cantons: the Swiss, however, united as one man, inflamed with anger at the assumption of lordship over them, and goaded to fury by the desperate nature of their case, met the Austrians at Morgarten, opposed untrained valour and unarmed bodies to skilled courage and armour-covered men-at-arms, and utterly defeated their enemies with dreadful slaughter (November 16, 1315).

This victory, which has been called the Marathon of Switzerland, secured the independence of the three cantons, and attracted, after some delay, the contiguous district of Lucerne, which was incorporated with the confederacy. About thirty years later Zurich, Glaris, Zug, and Berne joined the league, and these eight cantons remained till the Swiss revolution in 1830 to enjoy privileges and even sovereignty over many of the surrounding districts. Zurich and Berne were already independent and republican in their form of government before the formation of the union, but they secured additional strength not only for the maintenance of their existing power, but also for the object which they now proceeded to execute, that of curtailing the influence of the rural nobles. Small wars, having this aim in view, were carried on between the towns and the nobles, in which the latter fared badly, the wisest among them making their peace betimes by consenting to sink their rank and dignity, and to secure their property by identifying themselves as "citizens" of the dominant towns. For eighty years there was not any attempt from without to destroy the palladium of liberty which was being reared among the mountains of Helvetia. The nations had other things to do than to attend to so seemingly insignificant a place; and even the Dukes of Austria, while retaining for a time their Swiss hereditary possessions, did not find it convenient to cross swords with their co-protectors after the battle of Sempach (July 9, 1386). In this, the last of a series of encounters with the Austrians, all of which had been bloody and none inglorious for Switzerland, the Austrian knights dismounted and presented their lances as a steel hedge of pricks to the Swiss. It was necessary to break their line, and Winkelried of Unterwald, seeing no other way, commended himself to Heaven, and his wife and children to his country, and gathering as many lances' points as he could embrace, received them in his body, and so opened a way to the ingress of the Swiss with their five-feet-long swords. The Austrians were overthrown, and in the end the dukes alienated to the Swiss the lands and lordships of the Counts of Hapsburg. During this time power had become consolidated; and when the attention of surrounding nations was drawn to the country, by the prompt resentment of some injury done to its people, by the fearless, or, as it was then called, insolent way in which the Swiss threw back a rebuke or threat, it was found that the people were a kind of human conglomerate, hard and strong flints from which fire might be struck, but against which it would be unwise to hurl oneself. Nevertheless, about the year 1440 it seemed good to the despots and autocrats of the day to undertake the destruction of the home of liberty, as being too near their own dominions to be safe. The princes of Western Germany formed an association, which had the approval of the Emperor, for the purpose of subjugating Switzerland, and, the Duke of Burgundy having declined the use of his army, applied to the King of France for help. The King of France was only too glad of a pretext for getting rid of the numerous bands of adventurers who filled every one of his cities with uproar, men who were the offscourings and the refuse of the Anglo-French wars. He raised a large army, in which all these cut-throats were enrolled, and put it under the command of the Dauphin. Away the French prince marched, and laid siege to Basle before the Swiss knew he was coming. The men of Basle defended themselves as best they could, and sent off messengers to the Swiss army for help. Help came in the shape of 2,000 men, who did not hesitate to engage an army of which the advanced guard was ten times more numerous than they. The Swiss fought with desperate valour (26th of August, 1444), and were cut to pieces on the ground where they stood; but the victory cost the Dauphin (afterwards Louis XI.) 8,000 of his best troops, and impressed him so much that he made peace and retired; and subsequently, when he came to the throne, he entered into an alliance with his former foes.

In 1476 the last grand attack was made on Switzerland with the view of bringing her again under feudal bondage. Charles the Bold, the last Duke of Burgundy, proposed the task to himself, both because the Swiss were allies of his inveterate enemy, Louis XI., and because he hated the bare idea of popular freedom. With a splendid army of 36,000 men, furnished with everything necessary for the campaign, he marched into the country and

laid siege to Yverdun. The garrison cut their way out, and retired to Granson, whither Charles proceeded, and having induced the garrison, after a desperate resistance, to offer to capitulate, he murdered in cold blood the governor and 200 of his officers who had put themselves in his power.

Every man in Switzerland took up arms; and when, shortly after the bloody deed just recited, the Swiss came upon the Burgundian army in the mountain passes near Neuchâtel, they smote them hip and thigh to the shout of "Granson! Granson!" so that the splendid army melted like snow off the mountains. Charles strained every nerve to retrieve his loss. He procured money from Flanders and Brabant, melted church bells to make cannon, and hired troops from anywhere to assist him; but it was not till many weeks after his defeat that he was able to take the field, and then it was to make a gambler's last desperate throw. In May, 1476, he laid seige to Morat, the key of Berne and the door to Switzerland. He pressed the garrison so hard that they were about to surrender, when the Swiss army came to their relief. A furious battle ensued, in which rivers of blood were spilt, and the Burgundian army was utterly destroyed, for the Swiss refused to give quarter. Charles fled, and from that day forth abandoned his warlike intentions against the cantons. Not they theirs against him. In January of the following year (1477) they joined the Duke of Lorraine in resisting an attack which Charles was making on his province, and on the 4th of that month they had the satisfaction of again beating their enemy at the battle of Nancy.

In the year 1499 the independence of the Swiss cantons was formally recognised by the Emperor, and since that time it was never impeached till Napoleon overran the country, as he did all other countries in Europe, and revolutionised its institutions. The political constitution now in force is that which was settled in 1830, when the lesser cantons were admitted to equal rights with the greater, and certain mediæval privileges and customs which savoured of injustice and obsoletism were swept away.

See:—Cassell's Universal History; Fyffe, Modern Europe.

GREEK.—II.

(Continued from p. 23.)

PRELIMINARY INSTRUCTION IN THE VERB.

BEFORE we proceed to treat of nouns, we must say a few words respecting the verb, inasmuch as without some knowledge of the verb you will be unable to form sentences, as we intend you should from your earliest acquaintance with the Greek grammar. Parts of the verb *εἶναι, to be,* are indispensable. we here put down such as you will want, together with the corresponding English, or what is commonly called "the meaning."

PARTS OF THE VERB *εἶναι* TO BE.

εἰμί, I am.	*εἶ*, thou art.	*ἴσθι*, be thou.
ἐστί, he, she, *or* it is.	*ἦν*, he, she, *or* it was.	*ἔστω*, let him be.
εἰσί, they are.	*ἦσαν*, they were.	*ἔστε*, be ye.

Observe that *ἐστί* and *εἰσί* become *ἐστίν* and *εἰσίν* before a word beginning with a vowel.

Observe also that the Greek *ἐστί* is the Latin *est*, and the English *is*.

In the Greek language verbs have three voices, whereas in Latin and in English verbs have only two. If in English I say *I strike*, I express myself in what is called "the active voice"; but if I say *I am struck*, I express myself in what is termed "the passive voice." These two voices exist in Greek thus—

Active.	*Passive.*
τύπτω, I strike.	*τύπτομαι*, I am struck.

Here you observe that the passive is made by adding to the stem *τυπτ-* the suffix *-ομαι* instead of the letter *-ω*, by which the first person singular of the active is formed.

The Greeks have a third voice. In the present tense this voice is not distinguished in form from the passive; being the same word *τύπτομαι*. In signification, however, the third voice differs from the active and the passive. This third voice, under the name of *the middle voice*, denotes a reflex action, that is, an action which turns back on the agent or actor, as *τύπτομαι*, *I beat myself.*

Commit thoroughly to memory this table of *βουλεύω*, *I advise*, which contains such parts of the verb as you are likely to want in learning to form the nouns, the adjectives, etc.

INDICATIVE MOOD.

	Present Active.	*Present Passive.*
S. 1.	*βουλεύ-ω*, I advise.	*βουλεύ-ομαι*, I am advised.
2.	*βουλεύ-εις*, thou advisest.	*βουλεύ-ῃ*, or *-ει*, thou art advised
3.	*βουλεύ-ει*, he advises.	*βουλεύ-εται*, he is advised.
P. 1.	*βουλεύ-ομεν*, we advise.	*βουλευ-όμεθα*, we are advised.
2.	*βουλεύ-ετε*, you advise.	*βουλεύ-εσθε*, you are advised.
3.	*βουλεύ-ουσι(ν)*, they advise.	*βουλεύ-ονται*, they are advised.

IMPERATIVE MOOD.

1. βούλευ-ε, advise thou. βουλεύ-ου, be thou advised.
2. βουλεύ-ετε, advise ye. βουλεύ-εσθε, be ye advised.

INFINITIVE MOOD.

βουλεύ-ειν, to advise. βουλεύ-εσθαι, to be advised.

The middle signification is sometimes best rendered by another word; thus, instead of saying, *I advise myself*, we may say, *I consult*, or *I take advice*.

Observe how these several changes in the terminations are produced. The stem, or permanent form of the word, is βουλευ-. To βουλευ-, the endings, -ω, -εις, -ει, -ομεν, -ετε, -ουσι, are added, according to the person and number you may wish to form. Thus, to form the infinitive active, corresponding with our English *to advise*, you add -ειν to βουλευ-, and so produce βουλεύ-ειν. If you wish to put into Greek our *advise thou*, you add -ε to βουλευ-, and so produce βούλευ-ε, the second person singular of the imperative mood. You proceed in the same way with any other verb. In order to make the matter clear, we put the endings here apart from any verb:—

PERSON-ENDINGS.

INDICATIVE MOOD.

		Present Active.	*English Sign.*	*Present Passive.*
Sing.	1.	-ω	I	-ομαι.
	2.	-εις	thou	-ῃ, or -ει.
	3.	-ει	he	-εται.
Plur.	1.	-ομεν	we	-ομεθα.
	2.	-ετε	you	-εσθε.
	3.	-ουσι	they	-ονται.

IMPERATIVE MOOD.

Sing.	-ε	thou	-ου.
Plur.	-ετε	ye	-εσθε.

INFINITIVE MOOD.

-ειν	to	-εσθαι.

VOCABULARY.*

Ἄγαν, too much.
Ἀεί, always (*English* aye).
Ἀληθεύω, I speak the truth.
Ἀνδρείως, bravely.
Ἀριστεύω, I am the best, I excel.
Βιοτεύω, I live.
Βλακεύω, I am idle, luxurious.
Γράφω, I write.
Διώκω, I pursue, strive.
Εἰ, if.
Ἕπομαι, I follow (*with dative*) (*middle voice*).
Ἐσθίω, I eat, consume.
Ἔχω, I have; ἔχει, *with an adverb*, it is; as εὖ ἔχει, it is well.
Ἡδέως, sweetly, pleasantly.
Θαυμάζω, I admire.
Καί, and.
Κακῶς, badly, ill.
Καλῶς, well, beautifully.
Κολακεύω, I flatter.
Μάχομαι (*with dative*) I fight (*middle voice*).
Μετρίως, moderately.
Μή (*with imperative*, *Latin* ne), not, do not.
Ὀδύρομαι, I complain, bewail.
Οὐ (*before consonants*, οὐκ or οὐχ *before vowels*), not, no.
Παιδεύω, I educate.
Παίζω, I play.
Πίνω, I drink.
Πιστεύω, I believe.
Σπεύδω, I hasten, strive after.
Φεύγω, I flee (*Latin* fugio).
Χαίρω, I rejoice.
Ψέγω, I blame.

* v. directions infra.

EXERCISE 1.

Translate into English:—

1. Ἀεὶ ἀλήθευε. 2. Χαίρετε. 3. Ἕπου. 4. Μὴ ὀδύρεσθε. 5. Ἡδέως βιοτεύω. 6. Καλῶς παιδεύομαι. 7. Καλῶς γράφεις. 8. Εἰ κακῶς γράφεις, ψέγῃ. 9. Σπεύδει. 10. Ἀνδρείως μάχεται. 11. Εἰ κολακεύετε, οὐκ ἀληθεύετε. 12. Εἰ κολακεύεις, οὐ πιστεύῃ. 13. Φεύγομεν. 14. Εἰ φεύγομεν, διώκομεθα. 15. Κακῶς φεύγετε. 16. Εἰ βλακεύετε, ψέγεσθε. 17. Εἰ ἀνδρείως μάχεσθε, θαυμάζεσθε. 18 Εἰ κολακεύουσιν, οὐκ ἀληθεύουσιν. 19. Οὖ καλῶς ἔχει φεύγειν. 20. Καλῶς ἔχει ἀνδρείως μάχεσθαι. 21. Εἰ διώκῃ, μὴ φεῦγε. 22. Ἀνδρείως μάχου. 23. Εἰ βλακεύουσι, ψέγονται. 24. Εἰ ἀληθεύεις, πιστεύῃ. 25. Ἀεὶ ἀριστεύετε. 26. Μετρίως ἔσθιε καὶ πῖνε καὶ παῖζε.

EXERCISE 2.

Translate into Greek—

1. I speak the truth. 2. Thou speakest the truth. 3. He speaks the truth. 4. We speak the truth. 5. You speak the truth. 6. They speak the truth. 7. If I speak the truth, I am believed. 8. Do not fight. 9. They fight. 10. Follow ye. 11. Thou followest. 12. Ye follow. 13. He plays. 14. They fly. 15. If they flee, they are pursued. 16. I am admired. 17. They are admired. 18. If they are idle, they are not admired. 19. It is well to fight bravely. 20. He eats and drinks moderately. 21. They do not hasten. 22. If thou flatterest, thou art not admired. 23. He writes well. 24. They write badly. 25. It is well to be always the best. 26. You live moderately. 27. They eat too much.

We will now give you some directions as to these exercises. First, then, you must repeat each word in the vocabulary until you have impressed it indelibly upon your memory. Then proceed, with the aid thus gained, to translate the Greek sentences into English, and put the English words into their corresponding Greek words, paying due regard to the model or pattern given you here and in other cases. In translating from the one language into the other, you may derive aid from consulting the Greek and the English as given in the exercises;

that is, if you are translating from Greek into English, consult the exercise given in English, finding the example most like the one you have to translate; and if you are translating from English into Greek, then in the same way consult the exercise given in Greek. Do not be in haste to advance, but be very careful to do everything thoroughly; make every first step sure before you attempt to take a second step. Bear in mind the Latin proverb "festina lente," *hasten slowly;* in English, "slow and steady wins the race." Don't be content with writing an exercise once: write it again and again; and when you think you have made it quite correct, then commit it to memory.

Greek is a language in which compounds are readily and copiously formed. It may, in consequence, be acquired with comparative ease, provided the student is trained in the formation of the compounds. The necessary instructions we shall endeavour to impart. With this view we shall supply lists of words etymologically connected with those which are given in the vocabulary. A knowledge of one word will thus become to the learner a knowledge of several. Let us take, as an instance, the verb βουλεύω, the present tense of which stands above. Βουλεύω, *I advise*, comes from βουλή, *advice* or *counsel:* βουλή leads to βουλεία, *the dignity* or *office of a counsellor;* thence we derive βουλεῖον, *a council-house;* βούλευμα, *a determination;* βουλευτής, *a counsellor;* βουληγορέω, *to speak in a council;* besides other terms. These words are again modified in meaning, as well as multiplied by means of prepositions; *e.g.*, in combination with σύν, *with*, βουλή forms another set of terms, as συμβούλευμα, *a resolution;* συμβούλευσις, *the communication of a resolution;* συμβουλευτής, *a joint counsellor:* συμβουλεύω, *I give counsel:* σύμβουλος, *a senator*. It would be easy to extend this list. But without going further, here are eleven words connected in origin, form, and meaning with one word. When, then, you know that one, you have a key to all the rest. With a few roots, you thus see, you would soon become master of a copious vocabulary; and as the roots of the language are not numerous, the acquisition of it, when rightly studied, is by no means a very difficult task.

N.B.—The roots will be printed in capitals. Let the Etymological Vocabulary, no less than the above Vocabulary for the Exercises, be thoroughly committed to memory.

ETYMOLOGICAL VOCABULARY.

ΑΛΗΘΉΣ, true.
Ἀληθεύω, I am true.
Ἀλήθεια, truth.
Ἀλήθευσις, truthfulness.
Ἀληθινολογία. truth-speaking.
Ἀλήθινος, true, genuine.
Ἀληθόμαντις, a true soothsayer.
ἌΡΙΣΤΟΣ, best.
Ἀριστεύω, I am best *or* first.
Ἀριστοφυής, of best nature.
Ἀριστόμαντις, the best soothsayer.
Ἀριστοπόνος, an excellent labourer.
Ἀριστοτέχνης, an excellent artist.
Ἀριστοκρατία, government of the best, aristocracy.
ΒΊΟΣ, life.
Βιοτεύω, I live.
Βιοσσόος, life-saving.
Βιοτεία, the art of life.
Βιοφθορία, a destruction of life.
Βιόω, I am alive.
Βιωτικός, serviceable to life.
ΓΡΆΦΩ, I engrave, write.
Γραφή, a writing.
Γραφεῖον, a writing tool.
Γραφεύς, a writer.
Γραφικός, pertaining to writing.
Γράμμα, a written letter.
Γραμμάτεια, the art of writing.

In the word ἀληθινολογία, *truth-speaking*, there are two compounds, namely, ἀλήθινος from ἀληθής, and λόγος: λόγος means speech, a word. Ἀληθινολογία is then a compound word, resembling in form as well as import this term which we coin for the purpose of illustration, namely, *truth-speaking*. Take another instance from our own language. *Aristocracy* is made up of ἄριστος, *best*, and κρατέω, *I rule*, and so signifies, not *best government*, but *the government of the best*.

You cannot obtain all the information contained in the Etymological Vocabulary until you know the second word which enters into combination with each separate root. We shall therefore supply these second terms, together with their significations.

SECONDARY COMPONENTS.

Κράτος, strength.
Λόγος, speech.
Μάντις, a diviner, a foreteller.
Πόνος, labour.
Τέχνη, art.
Φθορά, destruction.
Φύω, I bring into existence.

Obs.—Note that the pronoun is implied in the verb, and consequently you do not need a separate pronoun in translating. Thus γράφω is *I* write; involving the pronoun *I*, as well as the verb *write*. So γράφει is *he* writes, and γράφομεν is *we* write.

GENERAL REMARKS ON THE NOUN, THE ADJECTIVE, AND THE PREPOSITIONS.—THE DEFINITE ARTICLE.

GENDER.

Nouns or Substantives are names of objects or things which exist in space or in the mind. There are, in Greek, three genders; the masculine, to denote the male sex; the feminine, to denote the female sex; and the neuter (Latin neuter, *neither*), to denote objects which are neither male nor female.

The genders are distinguished partly by the sense and partly by the terminations of the nouns. There are terminations, for instance, which denote the feminine gender, as -η; there are other terminations which denote the masculine gender, as -ας in the first declension; and, again, there are others which denote the neuter gender, as -ον. This is a peculiarity to which we have nothing similar in English adjectives. Those who have studied Latin are already familiar with it. In regard to gender as denoted by the meaning, let the ensuing rules be committed to memory.

1. Of the *masculine gender* are the names of male beings, of winds, of months, and of most rivers, as:—Πλάτων, Plato; Ζέφυρος, the west wind; Ἑκατομβαιών, the month Hecatombæon; Εὐρώτας, the river Eurotas.

2. Of the *feminine gender* are the names of female beings, of trees, of lands, of islands, and of most cities, as:—Κόρη, a girl; δρῦς, an oak; Ἀρκαδία, Arcadia; Λέσβος, Lesbos; Κολοφών, Colophon.

3. Of the *neuter gender* are the names of fruits, the diminutive in ον, the names of the letters of the alphabet, the infinitives, all words not declinable in the singular and the plural, and every word used merely as the sign of a sound.

4. Of the *common gender* are personal nouns which, like our *child*, may be applied to male or female; thus, Θεός may be sometimes used of a male or female divinity, and so be rendered either *god* or *goddess*

This "common gender" is a grammatical phrase used to denote such nouns as are common to both males and females; that is, are sometimes masculine and sometimes feminine.

In Greek grammar it is usual to employ the definite article in order to indicate the gender. The definite article, nominative singular, is ὁ, ἡ, τό, *the;* ὁ is masculine, ἡ feminine, and τό neuter; ὁ, therefore, put before a noun, intimates that the noun is of the masculine gender; ἡ, that the noun is of the feminine gender; and τό, that it is of the neuter gender. If both ὁ and ἡ are put before a noun, it is done to show that the noun is of the common gender: thus, ὁ ἀνήρ, *the man;* ἡ γυνή, *the woman;* τὸ ἔργον, *the work;* ὁ, ἡ, θεός, *the* (male or female) *divinity;* ὁ, ἡ, παῖς, *the child*, whether boy or girl.

NUMBER.

Number is a distinction of nouns founded on the circumstance whether they denote one or more. If a noun denotes one object, it is in the singular number; if a noun denotes more objects than one, it is in the plural number. The Greek tongue has a third number, called the dual (Latin duo, *two*), which denotes two objects; thus, λόγος is *a word* (singular); λόγοι, *words* (plural); λόγω, *two words* (dual): where -ος is the singular termination, -οι the plural termination, and -ω the dual termination. It is, however, but little used, except of pairs of things, *e.g.*, the two eyes, the two hands.

CASE.

These terminations, -ος, -οι, -ω, undergo changes according to the relation in which they stand to a verb, to another noun, or to a preposition. Thus -ος may become -ον, and -οι may become -ους. Any word which is changed in form to express a corresponding change in sense, is said to be inflected. Such inflections or variations in the endings of nouns are termed cases. There are in Greek five cases, namely—

1. *The Nominative*, the case of the subject; as, ὁ πατὴρ γράφει, *the father* writes.

2. *The Genitive*, the case indicative of origin, *whence;* as, ὁ τοῦ πατρὸς υἱός, the *father's* son.

3. *The Dative*, the case indicative of the person or thing more remotely concerned, and of the place, manner, and instrument; as, τῷ τοῦ πατρὸς υἱῷ, to the father's *son*.

4. *The Accusative*, the case of the object, or *whither;* as, ὁ πατὴρ τὸν υἱὸν ἀγαπᾷ, the father loves *the son*.

5. *The Vocative*, the case of invocation, or direct address; as, ἀγάπα, πάτερ, τὸν υἱόν, *father*, love thy son

In Greek there is no ablative case; the functions of the ablative case are discharged partly by the dative, and partly by the genitive. The nominative and the vocative are called recti, *direct:* the other cases are called obliqui, *indirect*.

Substantives and adjectives of the neuter gender have the nominative, the accusative, and the vocative alike, in the singular, the plural, and the dual

The dual has only two case-endings: one for the nominative, accusative, and vocative, the other for the genitive and dative.

DECLENSION.

Declension is the classification of nouns and adjectives agreeably to the variations of their case-endings. There are, in Greek, three declensions, called severally the first, the second, and the third declension. The learner will do well in regard to every noun and adjective, to ask himself, What is its nominative? What is its case? What is its number? What is its gender? What is its declension? For instance, τραπέζαις is from the nominative τράπεζα, *a table*, is in the plural number, dative case, feminine gender, and of the first declension. In order to practise and examine himself fully, he should also form or "go through" every noun, adjective, tense, mood, and indeed every word capable of declension or conjugation,

according to the several models or paradigms given in the successive lessons.

THE ADJECTIVE.

An adjective denotes a quality. This quality may be considered as being connected with, or as being in, an object, as "the *red* rose," or as ascribed to an object, as "the rose is *red*." In both cases the adjective in Greek, as in Latin, is made to agree in form, as well as in sense, with its noun. A change takes place in the adjective, conformably to the change in the signification; thus, *a good man* is ἀγαθὸς ἀνήρ, but *a good woman* is ἀγαθὴ γυνή. Observe the -ος of the masculine is for the feminine changed into -η. Not only in gender, but in number and in case, does the adjective in Greek, as in Latin, conform to its noun: *e.g.*, ὁ ἀγαθὸς ἄνθρωπος, Latin, *bonus* homo, *the good man*; ὁ ἄνθρωπός ἐστιν ἀγαθός, homo *bonus* est, *the man is good*; ἡ καλὴ Μοῦσα, *pulchra* Musa, *the beautiful Muse*; ἡ Μοῦσα ἐστὶ καλή, Musa *pulchra* est, *the Muse is beautiful*; τὸ καλὸν ἔαρ, *pulchrum* ver, *the beautiful spring*; τὸ ἔαρ ἐστὶ καλόν, ver *pulchrum* est, *the spring is beautiful*.

The adjective, then, like the substantive, has a threefold gender—the masculine, the feminine, and the neuter. But many adjectives, such as *compound* and *derivative*, have only two terminations; one for the masculine and feminine, and another for the neuter; *e.g.*:—

Masculine.	*Feminine.*	*Neuter.*
ὁ ἥσυχος ἀνήρ,	ἡ ἥσυχος γυνή,	τὸ ἥσυχον τέκνον,
the quiet man.	*the quiet woman.*	*the quiet child.*

Here ἥσυχος remains the same with ἀνήρ, *man*, and γυνή, *woman*, being changed into ἥσυχον before the neuter τέκνον, *child*. An adjective of three terminations may be seen in this example:—

Masculine.	*Feminine.*	*Neuter.*
ὁ ἀγαθὸς ἀνήρ,	ἡ ἀγαθὴ γυνή,	τὸ ἀγαθὸν τέκνον,
the good man.	*the good woman.*	*the good child.*

Some adjectives have only one termination, as μακρόχειρ, *long-handed*; ἀπάτωρ, *without a father*. In declension, adjectives, with a few exceptions, follow the forms of the substantives.

PREPOSITIONS.

Prepositions are words which go before nouns, and show the relation which the nouns bear to the statement made in the sentence, or the member of the sentence, in which they stand. Of prepositions we shall treat in full hereafter. At present some knowledge of them must be communicated, in order to prepare the beginner for the following instructions. In the words

πορεύομαι πρὸς τὸν πατέρα,
I go TO *the father*,

the word πρός, *to*, is a preposition.

In Greek, prepositions govern either one case, two cases, or three cases, and may accordingly be classified thus:—

PREPOSITIONS GOVERNING

One Case.	*Two Cases.*	*Three Cases*
	Genitive.	
Ἀντί, in presence of, instead of.	Διά, through.	Ἀμφί, about, concerning.
Ἀπό, from.	Κατά, down.	Ἐπί, upon.
Ἐκ, out of.	Ὑπέρ, for.	Μετά, with.
Ἕνεκα, on account of.		Παρά, from.
Πρό, before, for the good of.		Περί, concerning.
		Πρός, in front of, *or* from.
		Ὑπό, through, by.
	Dative	
Ἐν, in.		Ἀμφί, about (poetic).
Σύν, with.		Ἐπί, on.
		Μετά, amidst.
		Παρά, by, near (of rest).
		Περί, around.
		Πρός, at (of rest).
		Ὑπό, under (of place).
	Accusative.	
Ἀνά, up.	Διά, because of.	Ἀμφί and Περί, about.
Εἰς, into.	Κατά, through, down.	Ἐπί, to.
Ὡς, toward (of persons).	Ὑπέρ, over, beyond.	Μετά, after.
		Παρά, to the side of.
		Πρός, to (of motion).
		Ὑπό, under (of motion to).

A glance at this table will show that the case which in any example a preposition is connected with, has much to do in modifying its signification. Only by constant practice can the exact meaning and application of the several prepositions be known. The Latin student will, in this list, recognise words with which he is familiar; thus ἐκ is the Latin *ex*; ἐν is the Latin *in*; πρό is the Latin *pro*; ἀπό is the Latin *ab*; ὑπέρ is the Latin *super*; and ὑπό is the Latin *sub*.

Before we treat of the declension of nouns, we must give the definite article, as it is so intimately connected with nouns that the latter cannot well be set forth without the former; and as the article is often used as indicative of the gender of the noun.

THE DEFINITE ARTICLE. ὁ, ἡ, τό, *the.*

Singular.

	Mas.	Fem.	Neut.	English.
Nom.	ὁ	ἡ	τό	the.
Gen.	τοῦ	τῆς	τοῦ	of the.
Dat.	τῷ	τῇ	τῷ	to *or* by the.
Acc.	τόν	τήν	τό	the.
		Plural.		
Nom.	οἱ	αἱ	τά	the.
Gen.	τῶν	τῶν	τῶν	of the.
Dat.	τοῖς	ταῖς	τοῖς	to *or* by the.
Acc.	τούς	τάς	τά	the.
		Dual.		
Nom. Acc.	τώ	(τά)	τώ	the.
Gen. Dat.	τοῖν	(ταῖν)	τοῖν	of *or* to the.

There is no form for the vocative; ὦ, which is commonly used, is an interjection. The way to learn the article (as well as the adjective) is to repeat the parts first perpendicularly, ὁ, τοῦ, τῷ, τόν, etc., and then horizontally, as ὁ, ἡ, τό, until you are perfectly familiar with the whole. When you think you have mastered the task, examine yourself by asking. What is the accusative singular, feminine gender? What is the nominative plural, masculine gender? etc.; and when you have given an answer from memory alone, consult the book to ascertain whether you are correct. Finally, write out the article in full from memory. Indeed, spare no pains to make yourself master of the article. There is a special reason for this advice, since the terminations of the article are, in the main, the same as the terminations of the noun and the adjective.

ELECTRICITY.—V.

[*Continued from p. 18.*]

PRIMARY BATTERIES—CLASSES III. AND IV.

THE LECLANCHÉ — THE AGGLOMERATE — THE DANIELL—THE MINOTTO—FLEMING'S STANDARD DANIELL—CLARK'S STANDARD CELL.

The Leclanché Cell.—The form in which this cell is usually made up is illustrated in Fig. 13. The outer vessel consists of a square-bottomed glass jar, the upper portion of which is narrowed, allowing sufficient room for the porous pot to pass freely in; a small lip is also allowed for the zinc rod to pass through, and which is also convenient for filling or emptying the jar. The square shape of the jar allows a number of them to be stowed in a small space without any waste of room, and the narrowing of its upper portion reduces the evaporation of the liquid to the smallest possible amount.

The positive element consists of a circular zinc rod, and the aliment is a saturated solution of sal-ammoniac. The negative element is a carbon plate, which is placed in a porous pot and surrounded with a mixture of manganese dioxide and carbon in equal parts. The manganese dioxide acts as the depolarising agent, and is the one solid substance which is in general use for this purpose. The porous pot is used for the sole purpose of keeping the negative element surrounded with the mechanical mixture of manganese and carbon, and in some forms of the cell this pot is omitted.

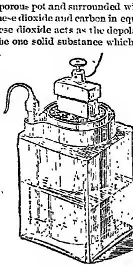


Fig. 13 – Leclanché Cell.

Drawn zinc of about half an inch in diameter is the best kind to use for the positive element Cast zinc is crystalline in structure, very brittle, very porous, and invariably contains a large number of impurities; it is consumed very irregularly during the working of the cell Rolled zinc is far less porous; it is not, however, uniformly attacked by the liquid, as may be seen by small scales forming on its surface. Rolled zinc is much better than cast, but is inferior to drawn zinc, which is much more homogeneous than either. Where the zinc is irregularly consumed, non-conducting crystals form on the roughened surface, which decrease the effective surface of the zinc and increase the resistance of the cell.

It is not customary to amalgamate the zinc rods; but though this precaution may not be necessary where the best drawn zinc is used, it is undoubtedly advisable to amalgamate the zincs usually sold with Leclanché cells; these zincs are seldom drawn, and though they are not attacked by the liquid when the cell is not working, still they are irregularly eaten away when the cell does work, and saline crystals form at the irregularities thus exposed, instead of dropping innocently to the bottom of the cell as they would otherwise have done. Amalgamation insures that the zincs will be consumed fairly uniformly.

The aliment should consist of a saturated, or nearly saturated, solution of sal-ammoniac; and it is of importance that it should be as pure as possible. The sal-ammoniac purified by sublimation is rather expensive, but is extremely good. If the solution is too weak, it is unable to dissolve the

crystals of oxychloride of zinc which are formed by the working of the cell, and which deposit on the zinc rods; a saturated solution, however, dissolves them readily and keeps the zincs clean. On the other hand, if too much sal-ammoniac is present, it will crystallise on the zinc and be as injurious as if the solution were too weak. Either too much or too little sal-ammoniac in the cell will produce non-conducting crystals on the zinc, which considerably increase the resistance of the cell. The cell should not be much more than half-filled with this liquid.

The porous pot is nothing more than a mechanical contrivance for keeping the mixture of manganese and carbon in its place, and is not used—as is usually the case—for separating two liquids. It should be as porous as possible, and on no account should it be allowed to come into contact with the zinc—a couple of rubber rings on the zinc will effectually prevent this.

The space round the negative element is tightly packed with a mixture of manganese peroxide and carbon. The best manganese to use for this purpose is that known as the needle variety; it is crystalline in structure, presents a silky appearance, is extremely hard, and has a comparatively low resistance. In order to make the mixture, the manganese should be crushed, and all the powdered portion removed, leaving only that which is in a fine granular state; this should then be mixed with an equal amount of granular carbon, and the mixture thus obtained should be forced tightly into the vacant space in the porous pot. The grains of carbon may be much larger than those of the manganese, but no powdered material should on any account be used. Both the manganese and the carbon are better conductors than the liquid which fills all the spaces between them, and for this reason the mixture should be as tightly packed as possible, so as to fill the space with good instead of bad conducting material.

Manganese dioxide is a substance rich in oxygen, which it gives up slowly at the ordinary temperature, but quickly on the application of heat. When used as a depolarising agent—as it is used in the Leclanché cell—it does its work very slowly, but at the same time it does it very thoroughly.

A modified form of the Leclanché cell, known as the **Agglomerate Type**, is illustrated in Fig. 14. Since the resistance of the cell increases with the distance between the elements, and decreases as the mixture is more tightly packed, it clearly is of advantage to have the elements as close as possible, and to have the mixture as tightly packed as possible; both these objects are attained in the agglomerate form, which also dispenses with the use of a porous pot. The mixture is made into slabs or blocks, one of which is placed at each side of the carbon plate, and the whole strapped together by two rubber bands; this arrangement is shown in Fig. 14, which also shows the manner in which the zinc rod is prevented from touching the block by interposing a piece of wood between them.

The composition of the depolarising blocks is as follows:—

Manganese dioxide	40 parts.
Carbon	52 „
Gum	5 „
Bisulphate of potash	3 „

The bisulphate of potash is added in order to dissolve the zinc salts which form in the pores of the mixture. The gum is added in order to bind the whole together into a compact mass. This mixture is heated to about 100° Cent., and then subjected to hydraulic pressure, with the result that slabs of any desired size and shape can be easily obtained. The resistance of this type is less than that of the ordinary form, and its E.M.F. is the same—about 1·45 at starting.

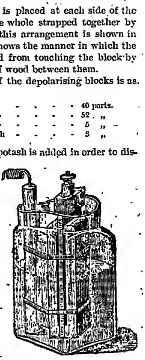


Fig. 14.—Agglomerate Leclanché.

For a short time the Leclanché cell can send a fairly strong current, but it quickly polarises, and its E.M.F. consequently falls: if the cell be allowed to rest for a time, and again tested, it will be found to have regained its original E.M.F. The explanation of this phenomenon is that the negative element becomes coated with hydrogen during the working of the cell, and polarisation therefore ensues; but when the cell is then allowed to rest, the manganese dioxide gives up a portion of its oxygen, which unites with the hydrogen on the carbon to form water, and the cell is thus restored to its original state.

The chemical action which occurs may be thus expressed (but it must be remembered that this action occurs in different stages):—

$$\underbrace{Zn}_{\text{Zinc.}} + \underbrace{2(NH_4Cl)}_{\text{Sal-ammoniac.}} + \underbrace{MnO_2}_{\text{Manganese dioxide.}} + \underbrace{C}_{\text{Carbon.}} =$$

$$\underbrace{ZnCl}_{\text{Chloride of zinc.}} + \underbrace{2NH_3}_{\text{Ammonia.}} + \underbrace{H_2O}_{\text{Water.}} + \underbrace{Mn_2O_3}_{\text{Manganese sesquioxide.}} + \underbrace{C}_{\text{Carbon.}}$$

This cell gives off no noxious fumes; it requires

no attention for months, and even then it only requires the addition of a little water to replace that which has evaporated: its resistance increases but comparatively slightly below freezing-point, and the liquid does not freeze at ordinary low temperatures; it is useless for giving continuous currents for any length of time, but for any kind of intermittent work requiring strong currents for short times, this cell is both effective and economical. There is scarcely any other cell used for ringing electric bells, and there is no other cell that would do the work as well.

Class IV.

CELLS IN WHICH POLARISATION IS PREVENTED BY ELECTRO-CHEMICAL MEANS.

No polarisation occurs in any of the cells belonging to this class provided they are in fair working

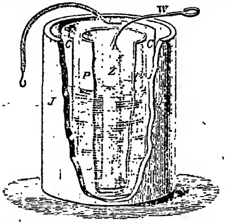


Fig. 15.—Daniell's Cell.

condition. In every case the negative element is surrounded by a solution of its own salt, and when a current is being generated this salt is decomposed, with the result that the metal contained in it is deposited on the negative element, and its place is taken by the hydrogen which is set free from the sulphuric acid; the hydrogen is thus prevented from ever coming in contact with the negative element, and polarisation is consequently avoided. The typical cell belonging to this class is the Daniell.

Daniell's Cell.—The form of this cell, which is illustrated in Fig. 15, is designed so as to render the resistance as small as possible. The outer vessel J J is a substantial vitrified earthenware jar about 7 inches in height. The negative element C C is a sheet of copper bent into circular form as shown, and immersed in a solution of sulphate of copper which fills about two-thirds of the jar. P P is a porous pot made of unglazed earthenware, and containing a solution of sulphuric acid. The positive element consists of an amalgamated zinc rod Z, to which the copper wire W, is attached.

As in the cells already described, the zinc is the fuel which is consumed in order to generate a current; it unites with the sulphuric acid to form sulphate of zinc, and hydrogen is thus set free. This hydrogen passes on to the porous pot, where it comes into contact with the solution of sulphate of copper. Reference to the table of heat-values shows that hydrogen has a higher heat-value than copper, and therefore it will displace the copper in the solution of sulphate of copper, and form sulphuric acid, whilst copper is set free. The copper thus set free is deposited in a finely divided state on the copper plate. The complete action which occurs may be expressed in chemical language thus:—

$$\underset{\textit{Zinc.}}{Zn} + \underset{\textit{Sulphuric acid.}}{H_2SO_4} + \underset{\textit{Sulphate of Copper.}}{CuSO_4} + \underset{\textit{Copper.}}{Cu}$$

$$= \underset{\textit{Sulphate of zinc.}}{ZnSO_4} + \underset{\textit{Sulphuric acid.}}{H_2SO_4} + \underset{\textit{Copper.}}{2Cu}$$

All these changes take place simultaneously with the generation of the current, and it is not necessary that the negative element should in the first instance consist of copper; in some forms of the Daniell cell the negative element originally consists of lead—which is much cheaper than copper—but after the cell has been working for a short time this lead becomes completely covered with a thin coating of copper, as explained by the above reaction, and from that moment forward it behaves exactly as if it consisted entirely of that substance.

Both solutions are continually undergoing a change in density—the sulphuric acid being converted into sulphate of zinc at the same time that the sulphate of copper is being converted into sulphuric acid. The E.M.F. of this cell is not a fixed quantity, but depends—within the limits of 1 and 1·15 volts—upon the densities of the solutions. The greater the density of the sulphate of copper, the higher is the E.M.F., and the greater the density of the sulphate of zinc the lower is the E.M.F.; whilst if the solutions have both the same density and the metals are pure, the E.M.F. will be 1·104 volts.

For ordinary work the sulphate of copper might be a saturated solution, and a few crystals of the sulphate might be placed in the bottom of the jar to keep up its strength; the other solution might consist of 10 parts of water to 1 of strong sulphuric acid.

The Minotto Cell.—Among the many modifications of the Daniell cell there is perhaps no more

useful one than that known as the Minotto. It is illustrated in Fig. 16.

The containing vessel J J consists of a highly vitrified earthenware jar. The materials used are the same as those in the Daniell already described, but their arrangement is different. The negative element consists either of a thin copper disc, or a flat spiral of copper wire; in either case it rests on the bottom of the jar; it is marked G, and is attached to a thoroughly insulated copperwire which may be seen passing up through the other constituents and hanging over the side of the jar. Resting on this disc or spiral is a layer of crystals of sulphate of copper, marked C S, and above this is a piece of canvas, marked C. On this canvas is placed a thick layer of sawdust S, and on this rests a substantial zinc disc Z, the two being separated by the piece of canvas C. To the zinc disc is attached the terminal B. A little water or sulphate of zinc is now poured in, so as to thoroughly moisten the sawdust, and the cell is complete.

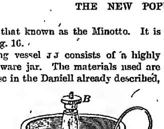


Fig. 16.—The Minotto Cell.

CONSTRUCTION OF CLARK'S STANDARD CELL.

(The following are the official instructions issued by the Board of Trade, 1898.)

"DEFINITION OF THE CELL.

"The cell consists of zinc and mercury in a saturated solution of zinc sulphate and mercurous sulphate in water, prepared with mercurous sulphate in excess, and is conveniently contained in a cylindrical glass vessel.

"PREPARATION OF THE MATERIALS.

"1 *The Mercury.*—To secure purity it should be first treated with acid in the usual manner, and subsequently distilled *in vacuo.*

"2. *The Zinc.*—Take a portion of a rod of pure redistilled zinc, solder to one end a piece of copper wire, clean the whole with glass paper or a steel burnisher, carefully removing any loose pieces of the zinc. Just before making up the cell dip the zinc into dilute sulphuric acid, wash with distilled water, and dry with a clean cloth or filter paper.

"3. *The Mercurous Sulphate.*—Take mercurous sulphate, purchased as pure, mix with a small quantity of pure mercury, and wash it thoroughly with cold distilled water by agitation in a bottle; drain off the water, and repeat the process at least twice. After the last washing drain off as much of the water as possible.

"4. *The Zinc Sulphate Solution.*—Prepare a *neutral*

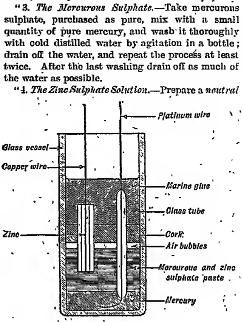


Fig. 17.—Clark's Standard Cell.

saturated solution of pure ("pure re-crystallised") zinc sulphate by mixing in a flask distilled water with nearly twice its weight of crystals of pure zinc sulphate, and adding zinc oxide in the proportion of about 2 per cent. by weight of the zinc sulphate crystals to neutralise any free acid. The crystals should be dissolved with the aid of gentle heat, but the temperature to which the solution is raised should not exceed 30° C. Mercurous sulphate treated as described in 3 should be added in the proportion of about 12 per cent. by weight of the zinc sulphate crystals to neutralise any free zinc oxide remaining, and the solution filtered, while still warm, into a stock bottle. Crystals should form as it cools.

"5. *The Mercurous Sulphate and Zinc Sulphate Paste.*—Mix the washed mercurous sulphate with the zinc sulphate solution, adding sufficient crystals of zinc sulphate from the stock bottle to ensure saturation, and a small quantity of pure mercury. Shake these up well together to form a paste of the consistence of cream. Heat the paste, but not above a temperature of 30° C. Keep the paste for an hour at this temperature, agitating it from time to time, then allow it to cool; continue to shake in

occasionally while it is cooling. Crystals of zinc sulphate should then be distinctly visible, and should be distributed throughout the mass; if this is not the case add more crystals from the stock bottle, and repeat the whole process.

"This method ensures the formation of a saturated solution of zinc and mercurous sulphates in water.

"Contact is made with the mercury by means of a platinum wire about No. 22 gauge. This is protected from contact with the other materials of the cell by being sealed into a glass tube. The ends of the wire project from the ends of the tube; one end forms the terminal, the other end and a portion of the glass tube dip into the mercury.

"TO SET UP THE CELL.

"The cell may conveniently be set up in a small test tube of about 2 cm. diameter, and 4 or 5 cm. deep. Place the mercury in the bottom of this tube, filling it to a depth of say 0·5 cm. Cut a cork about 0·5 cm. thick to fit the tube; at one side of the cork bore a hole through which the zinc rod can pass tightly; at the other side bore another hole for the glass tube which covers the platinum wire; at the edge of the cork cut a nick through which the air can pass when the cork is pushed into the tube. Wash the cork thoroughly with warm water, and leave it to soak in water for some hours before use. Pass the zinc rod about 1 cm. through the cork.

Fig. 18.—CLARK'S STANDARD CELL.

"Clean the glass tube and platinum wire carefully, then heat the exposed end of the platinum red hot, and insert it in the mercury in the test tube, taking care that the whole of the exposed platinum is covered.

"Shake up the paste and introduce it without contact with the upper part of the walls of the test tube, filling the tube above the mercury to a depth rather more than 1 cm.

"Then insert the cork and zinc rod, passing the glass tube through the hole prepared for it. Push the cork gently down until its lower surface is nearly in contact with the liquid. The air will thus be nearly all expelled, and the cell should be left in this condition for at least 24 hours before sealing, which should be done as follows.

"Melt some marine glue until it is fluid enough to pour by its own weight, and pour into the test tube above the cork, using sufficient to cover completely the zinc and soldering. The glass tube containing the platinum wire should project some way above the top of the marine glue.

"The cell thus set up may be mounted in any desirable manner. It is convenient to arrange the mounting so the cell may be immersed in a water bath up to the level of, say, the upper surface of the cork. Its temperature can then be determined more accurately than is possible when the cell is in air.

"In using the cell sudden variations of temperature should as far as possible be avoided.

"NOTES

"*The Zinc Sulphate Solution.*—The object to be attained is the preparation of a neutral solution of pure zinc sulphate saturated with $ZnSO_4$, $7H_2O$.

"At temperatures above 30° C. the zinc sulphate may crystallise out in another form; to avoid this 30° C. should be the upper limit of temperature. At this temperature water will dissolve about 1·9 times its weight of the crystals. If any of the crystals put in remain undissolved they will be removed by the filtration.

"The zinc sulphate should be free from iron, and should be tested before use with sulphocyanide of potassium to ascertain that this condition is satisfied. If an appreciable amount of iron is present it should be removed by the method given in the instructions for setting up Clark's cells issued from the Physical Technical Institute of Berlin (Zeitschrift für Instrumentenkunde, 1893, Heft 5).

"The amount of zinc oxide required depends on the acidity of the solution, but 2 per cent. will, in all cases which will arise in practice with reasonably good zinc sulphate, be ample. Another rule would be to add the zinc oxide gradually until the solution became slightly milky. The solution when put into the cell should not contain any free oxide; if it does then, when mixed with the mercurous sulphate, zinc sulphate and mercurous oxide are formed; the latter may be deposited on the zinc and affect the electro-motive force of the cell. The difficulty is avoided by adding as described about 12 per cent. of mercurous sulphate before filtration; this is more than sufficient to combine with the whole of the zinc oxide originally put in, if it all remains free; the mercurous oxide formed together with any undissolved mercurous sulphate is removed by the filtration.

"*The Mercurous Sulphate.*—The treatment of the mercurous sulphate has for its object the removal

of any mercuric sulphate which is often present as an impurity.

"Mercuric sulphate decomposes in the presence of water into an acid and a basic sulphate. The latter is a yellow substance—turpeth mineral—practically insoluble in water; its presence at any rate in moderate quantities has no effect on the cell. If, however, it is formed the acid sulphate is formed also. This is soluble in water and the acid produced affects the electro-motive force. The object of the washings is to dissolve and remove this acid sulphate, and for this purpose the three washings described in the Specification will in nearly all cases suffice. If, however, a great deal of the turpeth mineral is formed it shows that there is a great deal of the acid sulphate present, and it will then be wiser to obtain a fresh sample of mercurous sulphate rather than to try by repeated washings to get rid of all the acid.

"The free mercury helps in the process of removing the acid, for the acid mercuric sulphate attacks it, forming mercurous sulphate and acid which is washed away.

"Pure mercurous sulphate, when quite free from acid, shows on repeated washings a faint primrose tinge, which is due to the formation of a basic mercurous salt, and is distinct from the turpeth mineral or basic mercurous sulphate. The appearance of this primrose tint may be taken as an indication of the fact that all the acid has been removed, and the washing may with advantage be continued till this primrose tint appears. Should large quantities of this basic mercurous salt be formed, the sulphate should be treated as described in the directions already quoted (Zeitschrift für Instrumentenkunde, 1893, Heft 5).

"The cell may be sealed in a more permanent manner by coating the marine glue, when it is set, with a solution of sodium silicate and leaving it to harden.

"If the sides of the test tube above the cork be soiled by the introduction of the paste, the marine glue does not adhere to the glass; the liquid in the cell rises by capillary action between the glue and the glass, and may damage the cell.

"The form of the vessel containing the cell may be varied. In the H form (Fig. 18) devised by Lord Rayleigh, and modified by Dr. Kahle, the zinc is replaced by an amalgam of 10 parts by weight of zinc to 90 of mercury. The other materials should be prepared as already described. Contact is made with the amalgam in one leg of the cell, and with the mercury in the other, by means of platinum wires sealed through the glass."

For ordinary form of the cell *see* Fig. 17.

When this cell has been made for a few weeks, its E.M.F. becomes remarkably constant, and will remain so for years; it has the value 1·434 at a temperature of 15° Cent., but it changes with changes of temperature. At any other temperature its value is given by the formula

$$\text{E.M.F.} = 1{\cdot}434\,[1 - 0{\cdot}00077(t - 15°)]$$

where t is the new temperature.

This cell is not suitable for sending a current of any appreciable strength; it should not be used to send a current through a smaller resistance than 1,000 ohms, and if it is made to do so it will soon polarise, and its E.M.F. will fall.

BOTANY.—XVI.

[*Continued from p.* 28.]

DICOTYLEDONES—DISCIFLORÆ (*continued*)—CALYCIFLORÆ.

THE *Balsamineæ* are a small group of succulent and usually annual herbs, mostly belonging to the genus *Impatiens*. They have monosymmetric flowers with petaloid sepals, of which the posterior one is a large spur, whilst the two anterior ones are sometimes absent. The five petals appear as three, the two posterior ones adhering to the two lateral ones, and the anterior being much larger. The five anthers are coherent, and the five superposed carpels cohere into a five-chambered ovary which forms a loculicidal capsule, with numerous seeds in each chamber. This capsule when ripe splits elastically, the valves coiling away from the placentas and projecting the seeds to a distance, whence the name *Impatiens* and the specific name of *I. Noli-me-tangere* (Touch-me-not), the one British species.

The *Tropæoleæ* are an American group of herbs. The genus *Tropæolum*, which is mainly Peruvian, in some species produces tubers. Its leaves are commonly peltate; its flowers, monosymmetric, with a spur to the calyx; its petals, yellow, orange, or red, and often fringed; its stamens, eight in number; and its gynæceum, of three one-seeded fleshy carpels forming a regma. Some species—such as *T. aduncum*, the canary-creeper—climb by twisting their petioles round a support. The whole plant has a pungent taste, identical with that of cress, so that in the sixteenth century it was named Nasturtium, a name restricted by Linnæus to the Cruciferous genus to which the water-cress belongs. The same botanist gave this group their name, the shield-shaped leaves and helmet-like flowers suggesting a Greek trophy. The unripe fruits are pickled as a substitute for capers. *Limnanthes Douglasii*, a garden

annual, introduced from California by David Douglas, has pinnatifid leaves, but is mainly distinguished from *Tropæolum* by its polysymmetric yellow and white flowers with ten stamens.

The *Rutaceæ*, or rue family, natives of the Eastern hemisphere, have mostly divided leaves, both leaves and stems being thickly studded with glands containing an acrid-pungent volatile oil. The flowers are pentamerous, mostly polysymmetric, diplo- or triplo-stemonous, with the ovary raised on a gynophore dilated below into a glandular hypogynous disk.

Closely related to the rues are the *Aurantiaceæ*, or Orange tribe, shrubby plants, natives of tropical Asia, with oil-glands on the bark, leaves, sepals, petals, filaments, and epicarp. The leaves are evergreen and compound, with their petioles often winged, either reduced to the terminal leaflet, which has a distinct articulation at its base in addition to that at the base of the petiole, or ternate, as in *Choisya*. The stamens are originally five in number, but are variously branched (polyadelphous), and sometimes all united below (monadelphous). The gynæceum usually consists of more than five united carpels, with a cushion-like or cup-shaped disk below it, and a single terminal style. The fruit, sometimes termed a "hesperidium," is a form of nuculane, with a gold-coloured leathery epicarp, a woolly mesocarp, and a papery endocarp, from the inner surface of which a large-celled tissue is formed, with cells filled with watery cell-sap charged with citric and malic acids, sugar, etc. The seeds, of which there are usually two in each carpel, are exalbuminous, and often contain more than one embryo. *Citrus Aurantium* is the orange; *C. vulgaris*, the Seville orange; *C. Limonum*, the lemon; *C. medica*, the citron; *C. medica*, var. *acida*, the lime; *C. decumana*, the shaddock; and *C. japonica*, the kumquat. Bergamot oil, obtained from the unripe fruits of *C. Bergamia*, and various other essences obtained from the leaves, shoots, flowers, unripe fruits, and peel of various species, are largely used in perfumery, liqueurs, and—merely as flavourers—in medicine.

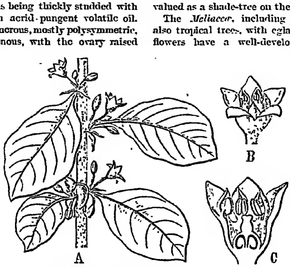


FIG. 73.—ALDER-BUCKTHORN (*Rhamnus Frangula*). B. Flower, C. The same in section.

To the allied, mainly tropical, tribe *Simarubeæ*—which have no oil-glands in the leaves, but a bitter substance in the bark and wood—belong the quassia or bitter-wood, and the *Ailantus*, a native of China, valued as a shade-tree on the Continent.

The *Meliaceæ*, including the *Cedrelaceæ*, are also tropical trees, with eglandular leaves. Their flowers have a well-developed disk and monadelphous stamens. Several invaluable timber-trees, such as crab-wood (*Carapa*), satin-wood, from the Bahamas (*Chloroxylon Swietenia*), toon or Moulmein cedar (*Cedrela Toona*), Honduras cedar, used for cigar-boxes, natural history cabinets, etc. (*C. odorata*), African oak (*Swietenia senegalensis*), and, above all, mahogany (*S. Mahagoni*), native to tropical America—belong to this group.

The only natural order of importance in the cohort *Olacales* is the *Ilicineæ* or *Aquifoliaceæ*, the holly tribe. These are evergreen trees, with petiolate, shining, coriaceous, simple leaves; small, polysymmetric, white or greenish flowers, which are often unisexual; a persistent calyx and a superior fruit of two or more united one-seeded carpels with fleshy mesocarp and bony endocarp, a nuculane which has been said to be composed of agglomerated drupes or *pyrenes*. Most of the species contain a bitter principle, *ilicine*; and the leaves of our common holly (*Ilex aquifolium*) are used as tea in the Black Forest, as are those of *I. Paraguayensis*, "yerba de maté," throughout South America. The common holly has its leaves, especially the lower ones, spinously dentate, and its flowers often regularly tetramerous, *i.e.*, with the formula 4. 4. 4. (4). Its wood is used for sticks, whips, handles of tea-kettles, as imitation ebony, and in inlaying; and from its viscid inner bark bird-lime is prepared.

The cohort *Celastrales* includes three orders of interest—the *Celastrineæ*, *Rhamneæ*, and *Ampelideæ*. The *Celastrineæ* are mostly shrubs, with scattered, simple, stipulate, evergreen or deciduous leaves,

cymes of small flowers, a well-developed disk, perigynous insertion, and an aril to the seeds. Our only British species, the spindle-tree (*Euonymus europæus*), has a pink loculicidal capsule containing four seeds with scarlet arils.

The *Rhamneæ*, or buckthorn family, are trees and shrubs, often spinous, with simple, usually stipulate, leaves, and small greenish flowers with valvate æstivation. The stamens are opposite the petals, both being perigynous. The bark and fruit contain a bitter principle, and several species furnish green dyes. *Rhamnus Frangula*, the alder-buckthorn or berry-bearing alder (Fig. 73), furnishes the best gunpowder charcoal.

The *Ampelideæ*, or *Vitaceæ*, are a small group of climbing shrubs, having in several cases some of their branches converted into branched tendrils, palmate or palmately lobed leaves, valvate æstivation, stamens opposite the petals, a hypogynous disk, and the fruit a nuculane. They inhabit all the intertropical region, and especially that of Asia. Beyond the tropics they are rare, more especially south of the Tropic of Capricorn. None are found indigenous to Europe; and if wild vines are found in the forests of this continent, the plants are to be regarded as having escaped from cultivation. The grape-vine (*Vitis vinifera*) is structurally interesting, from its tendrils often bearing compound racemes of flowers (Fig. 40, Vol. III., p. 209), and its petals cohering at their tips and falling in a little star as the flower opens. The true country of the vine seems to be Mingrelia and Georgia, between the mountains of the Caucasus, Ararat, and Taurus. The most ancient traditions mention the vine as having been made use of by man; and it is now cultivated wherever the mean summer temperature is not below 66° Fahr. Besides the use of its fresh fruit for dessert and for fermentation into wine, large quantities of certain varieties are dried as currants and raisins. The North American genus *Ampelopsis*, the Virginian creeper, the tendrils of which enlarge at their points, and the tropical *Cissus discolor*, are valued garden plants.

The cohort *Sapindales*, consisting entirely of woody plants, contains two main orders—the *Sapindaceæ* and the *Terebinthaceæ*. The *Sapindaceæ*, or soap-nut family, taken in a wide sense, includes the *Acerineæ*, or maple group, as well as the *Sapindeæ*, to which the horse-chestnut belongs. The group takes its name from a saponaceous principle, *saponine*, present in the fruit, which lathers with hot water. The *Sapindeæ* have mostly compound leaves, mono-symmetric flowers, seven stamens, three out of a typical ten being suppressed, and a trilocular ovary. The horse-chestnut (*Æsculus hippocastanum*) has opposite, palmate, exstipulate leaves of seven leaflets, and a polygamous inflorescence consisting of a raceme of cicinal cymes, only the lower flowers of which produce fruit. The fruit is a fleshy loculicidal capsule, studded externally with scattered spines and divided internally into three chambers, one or two of which, and one ovule in each, are commonly suppressed. The large seeds, when ripe, have a glossy chestnut-brown testa, marked with a large hilum, and are exalbuminous. The genus *Nephelium* yields the Litchi and other valued Asiatic fruits. In the *Acerineæ* the leaves are opposite, exstipulate, and usually simple and palmately lobed, the flowers are polygamous but polysymmetric, and the two-chambered, four-ovuled ovary develops into a double samara, with only one seed in each chamber and a carpophore between the mericarps. The sycamore (*Acer Pseudo-platanus*) has pendulous racemes, and is valued as a shade-tree. Its wood—known in Scotland as "plane"—is white, and is largely used in turnery. All the species contain a good deal of sugar in their spring sap; but it is more especially prepared from *A. saccharinum* and allied species in New Brunswick and the New England States. *A. campestre*, the common maple, has erect racemes.

The *Terebinthaceæ* or *Anacardiaceæ* are trees often resinous or poisonous, with scattered, exstipulate leaves; flowers, small, polysymmetric, and often unisexual; disk perigynous, and fruit usually a drupe. They yield numerous fine varnishes, such as mastic from *Pistacia Lentiscus* and Japanese lacquer from *Rhus vernicifera*. The mango is the fruit of the East Indian *Mangifera indica*, and the oily green pistachio-nut is the seed of *Pistacia vera*, a tree cultivated throughout the Mediterranean region.

Coming next to the series *Calycifloræ*, we find that it includes both plants with apocarpous and superior ovaries, and others with syncarpous and even inferior ones, but that the petals and stamens are almost always in this group inserted on the expanded receptacle so as to be perigynous, or, if this receptacle forms a tube adherent to the ovary, epigynous. They are called *Calycifloræ* because this expanded receptacle was formerly termed the calyx-tube. The series includes five cohorts—*Rosales*, *Myrtales*, *Passiflorales*, *Ficoidales*, and *Umbellales*.

The *Rosales* have usually bisexual, polysymmetric, and pentamerous flowers with perigynous insertion, and one or more carpels which are free at first, though sometimes subsequently more or less united to the receptacular tube in their ovarian region. This cohort includes several large and important orders, viz., *Leguminosæ*, *Rosaceæ*, *Saxifragaceæ*, *Crassulaceæ*, and *Droseraceæ*.

The *Leguminosæ*, or pea and bean family, is second only to the *Compositæ* among Dicotyledons in point of number of its genera and species, containing, as it does, about 7,000 species in 400 genera. Nevertheless, it is a very natural order, its members agreeing, with very few exceptions, in a number of characters. It includes plants of all sizes. The leaves may be replaced by phyllodes, as in some acacias, or by tendrils, as in *Lathyrus Aphaca*, but, if present, they are generally scattered, compound, and stipulate. They may be palmate, as in lupine; ternate, as in clover; or pinnate, and are often sensitive, especially in *Mimosa*. The gynæceum consists of a single carpel, generally containing several ovules, and forming a legume, the dry fruit dehiscing by both sutures, which gives its name to the order. The ovules are generally anatropous, and the seeds exalbuminous. The order includes three sub-orders—the *Mimoseæ*, *Cæsalpinieæ*, and *Papilionaceæ*.

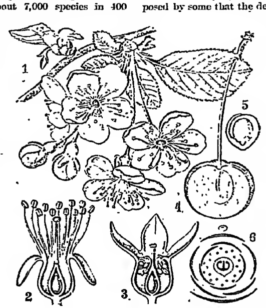


Fig. 74.—PRUNUS CERASUS.

2, Vertical Section through Flower; 3, Younger Stage; 4, Fruit in Section; 5, Stone (endocarp) with Seed.

The *Mimoseæ*, which are mainly tropical, and especially numerous in Africa and Australia, have polysymmetric flowers, with valvate æstivation and numerous stamens, the flowers generally crowded in a spike or head. This sub-order includes the genus *Acacia*, which produces gum-arabic, wattle-gums, mimosa-bark, etc.

The *Cæsalpinieæ*, also mainly tropical, have monosymmetric flowers, with imbricate but not papilionaceous æstivation, and generally ten stamens, or fewer, with their filaments not united. This sub-order includes logwood (*Hæmatoxylon campechianum*), a Central American tree, Brazil-wood (*Cæsalpinia echinata*), and sappan-wood (*C. Sappan*), yielding red dyes; *C. coriaria*, the astringent pods of which are used in tanning, under the name of divi-divi; the sennas (*Cassia*); tamarind (*Tamarindus indica*); copals (*Hymenæa*); Judas-tree (*Cercis siliquastrum*), and carob-bean or locust-bean, largely used in cattle-foods. The carob-bean (*Ceratonia siliqua*) is a very common tree on the shores of the Mediterranean, and its pulpy saccharine fruit is eagerly eaten by animals. It is supposed by some that the denomination *carat weight*, equal to $3\frac{1}{6}$ grains troy, employed by jewellers for weighing diamonds, etc., is derived from the seeds of this plant. It is more probable, however, that it is taken from the term *carat*, a name originally given to the seeds of the Abyssinian coral flower, or coral tree (*Erythrina abyssinica*). The seeds of this plant are very small and uniform in size and weight.

The *Papilionaceæ*, which include all the British representatives of the order, are characterised by their papilionaceous æstivation and ten stamens, which are either monadelphous, as in the furze (*Ulex*) and broom (*Cytisus*), or diadelphous, the upper or posterior one being separate from the other nine. This sub-order includes a great number of useful plants, their uses being of the most varied characters. Among them are edible seeds or pulse, farinaceous but rich also in nitrogen, thus affording the most valuable of human foods; herbaceous plants, with sweet and succulent foliage, the most useful fodder for cattle; dense and ornamental timbers; fibres, dyes, gums, oils, perfumes, and medicinal plants. Peas are the seeds of *Pisum sativum*; lentils, those of *Lens esculenta*, broad beans, those of *Faba vulgaris*; haricots, those of *Phaseolus vulgaris*, the unripe pods of which are eaten under the name French beans, as are those of the allied *P. multiflorus*, the scarlet-runner. The oily seed of the subterranean fruit of the tropical *Arachis hypogæa*, the ground-nut or pea-nut, though largely pressed for its oil, a substitute for olive-oil, is eaten by children, as is also the saccharine liquorice, extracted from the roots of *Glycyrrhiza*. The chief fodder-plants are the clovers (*Trifolium*), lucern (*Medicago*), vetches (*Vicia*), and sainfoin (*Onobrychis*). The trees of the order often form a dense dark-coloured heart-

wood, as in the laburnum (*Cytisus Laburnum*), in *Robinia*, and in the rose-woods of Brazil (*Dalbergia*); and the tough bast of *Crotalaria juncea* yields Bengal hemp. Gum tragacanth comes from various Levantine species of *Astragalus*, and the astringent kino from *Pterocarpus*. Indigo (*Indigofera tinctoria*) is the chief dye; and the tonka-bean (*Coumarouna odorata*) yields coumarin, the chief perfume in the order. The poisonous properties of many *Leguminosæ* reside mainly in their seed, as in laburnum and in the ordeal-bean of Calabar (*Physostigma venenosum*), which contains an alkaloid used in ophthalmic medicine as antagonistic to atropine.

The *Rosaceæ* form a smaller but more varied, though equally natural, order. Though their flowers are generally polysymmetric, and never papilionaceous, their stamens generally more than ten in number, and their carpels in many cases five or more, and fleshy, never forming a legume, the character which most clearly differentiates them from the *Leguminosæ* is that the odd sepal is posterior, whereas in the pea and bean tribe it is anterior. The flower in many members of the order closely resembles that of the *Ranunculaceæ*, differing in fact almost solely in the perigynous, instead of hypogynous, insertion of its petals and stamens. The order may be divided into seven tribes differing mainly in the nature of their gynæcea and fruits—the *Roseæ*, *Spiræaceæ*, *Drupaceæ*, *Sanguisorbeæ*, *Rubeæ*, *Potentilleæ*, and *Pomaceæ*. Of the *Roseæ*, the genus *Rosa* is the type. (Fig. 75.) Roses are prickly shrubs which have usually pinnate leaves of from three to seven leaflets with a sheath terminated above in stipules. The receptacular tube is ovoid and fleshy; the sepals, foliaceous, pinnatifid, and persistent; the petals, normally five; the stamens, indefinite; and the indefinite carpels, inclosed within the receptacular tube, forming an etærio of achenes. From the petals of the damask and other roses, rose-water and the oil known as attar of roses are obtained. The *Spiræaceæ*, which closely approach *Saxifragaceæ*, include the meadow-sweet (*Spiræa Ulmaria*), the cymes of creamy flowers of which are succeeded by rings of follicles, usually five in number. The so-called *Spiræa japonica* is truly Saxifragaceous, its name being *Astilbe barbata*. The *Drupaceæ* or *Amygdaleæ* are trees yielding gum, and sometimes spinous. They have simple leaves with sugar-glands on their petioles, their calyx is deciduous, and their fruit a drupe, *i.e.*, one superior carpel with two ovules, only one of which commonly forms a seed or "kernel," whilst the ovary forms a pericarp of three distinct layers—the epicarp, or "skin;" the mesocarp, or "flesh;" and the endocarp, or "stone." Their leaves and seeds contain prussic acid. *Amygdalus communis* is the almond, cultivated for its kernels; *A. persica*, the peach, with a woolly epicarp, and a smooth-skinned variety, the nectarine. *Armeniaca*, with woolly epicarp but smooth stone,

Fig. 75.—The Wild Rose or Dog-Rose.
1, The Flower Buds and Leaves; 2, Vertical Section of Flower; 3, Carpel; 4, Fruit; 5, Section of Carpel, showing Seed.

is the apricot: *Prunus*, with a glaucous epicarp, includes all the plums, *P. spinosa* being the blackthorn, with precocious blossoms; and *Cerasus*, with polished epicarp (Fig. 74), is the cherry group, *C. Laurocerasus* being the shrub commonly called laurel in England. The *Sanguisorbeæ* are mostly small herbs, with small, often tetramerous, and sometimes unisexual, flowers, and fruits consisting of from one to four achenes. *Alchemilla*, ladies-mantle, has palmately lobed leaves, with ochreate stipules and greenish flowers of four sepals, four petals, four stamens, with transverse dehiscence; a yellow, ring-shaped, perigynous disk; and a single carpel on a carpophore with a basilar style. Drops of water distil from the serrations of the leaf. *Poterium*, salad-burnet, has feathery stigmas to its two carpels, and is apparently wind-pollinated. *Rubeæ* includes the genus *Rubus*, the brambles and raspberries, prickly shrubs, the fruit of which is an otærio of drupels; whilst the *Potentilleæ*, distinguished by a stipular epicalyx and an etærio of achenes, include the strawberries (*Fragaria*), in which the achenes are scattered over a fleshy outgrowth from a receptacle. The *Pomaceæ* are trees with leaves mostly simple and branches sometimes spinous, their fruit being a pome of five carpels, or in the hawthorns (*Cratægus*), of two or only one, the receptacular tube becoming fleshy and adherent, and carrying up the marcescent calyx. *Pyrus* has parchment-like carpels or core, each with two seeds, *P. communis* being the pear, with turbinate pome; *P. Malus*, the apple, with its peduncle in a hollow or "umbilicus;" and *P. Aucuparia*, the mountain ash, with pinnate leaves. *Cydonia*, the quince, differs in having numerous seeds in each carpel; and *Mespilus*, the medlar, and the hawthorns, have stony cores.

ALGEBRA.—VIII.

[*Continued from p. 32.*]

INVOLUTION, OR RAISING OF POWERS.

173. *When a number is composed of the product of the same factor any number of times, the result is called a power of the factor. Powers are divided into different orders or degrees; as the first, second, third, fourth, fifth powers, etc., which are also called the root, square, cube, biquadrate, etc.*

The powers take their names from the number of times the *root*, or *first power*, is used as a *factor* in producing the given power.

The original quantity is called the *first power*, or *root* of all the other powers, because they are all derived from it.

Thus, if 2 be the roof or first power, then

$2 \times 2 = 4$, the square or second power of 2.
$2 \times 2 \times 2 = 8$, the cube or third power.
$2 \times 2 \times 2 \times 2 = 16$, the biquadrate or fourth power, etc.

And, if a be the root or first power, then
$a \times a = aa$, the second power of a.
$a \times a \times a = aaa$, the third power.
$a \times a \times a \times a = aaaa$, the fourth power, etc.

174. The *number* of times a quantity is employed as a *factor* to produce the given power is generally indicated by a *figure* or *letter* placed above it on the right hand. This figure or letter is called the *index* or *exponent*. Thus $a \times a = aa$, is written a^2 instead of aa; and $a \times a \times a = aaa$, is written a^3.

The *index* of the *first power* is 1; *but this is commonly omitted*, that is, $a^1 = a$.

An index is totally different from a *coefficient*. The *latter* shows how many times a quantity is taken as a *part* of a whole; the *former* how many times the quantity is taken as a *factor*. Thus $4a = a + a + a + a$; but $a^4 = a \times a \times a \times a = aaaa$. If $a = 4$, then $4a = 16$; and $a^4 = 256$.

175. Powers are also divided into *direct* and *reciprocal*.

Direct Powers are those which have *positive* indices, as d^2, d^5, etc., and are produced by multiplying a quantity by itself, as above described. Thus $d \times d = d^2$; $d \times d \times d = d^3$; and $d \times d \times d \times d = d^4$.

The *Reciprocal Power* of a quantity is the quotient arising from dividing a *unit* by the *direct* power of that quantity, as $\frac{1}{d^2}$, $\frac{1}{d^3}$, $\frac{1}{d^4}$, etc.

A reciprocal power is produced by dividing a *direct power* by its *root*, till we come to the root itself; and then *continuing* the division, we obtain the *reciprocal* powers. Thus $\frac{d^3}{d} = d^2$; and $\frac{d^2}{d} = d$; $\frac{d}{d} = d^0 = 1$; and $\frac{1}{d} \div d = \frac{1}{d^2}$; and $\frac{1}{d^2} \div d = \frac{1}{d^3}$, etc.

176. For convenience of calculation and expression, reciprocal powers are written like direct powers with the sign $-$ before the *index*; thus $\frac{1}{d^2} = d^{-2}$, etc. The direct and reciprocal powers of d are d^4, d^3, d^2, d^1, d^0, d^{-1}, d^{-2}, d^{-3}, d^{-4}, etc., in which $d^0 = 1$.

177. INVOLUTION *is the process* of finding any power of a quantity, as explained in Art. 173.

178. To involve a quantity to any required power.

RULE.—*Multiply the quantity by itself, and by its successive products, till it is taken as a factor as many times as there are units in the index of the power to which the quantity is to be raised.*

All powers of unity or 1 are the same, viz, 1 For $1 \times 1 \times 1 \times 1$ etc $= 1$

179 A *single letter* is involved or raised to any power, by giving it the *index* of the proposed power, or by repeating it as a factor as many times as there are units in that index

If the letter or quantity has a *coefficient*, it must be raised to the *required power* by *actual multiplication*

Examples

1 The 4th power of a is $aaaa$, or a^4

2 The 6th power of y is $yyyyyy$, or y^6

3 The nth power of x is xxx repeated n times, or x^n.

180 The method of involving a quantity which consists of several *factors*, depends on the principle, that *the power of the product of several factors is equal to the product of their powers*

Example —What is the square of ay? Here, $(ay)^2 = a^2y^2$ For, by Art 178, $(ay)^2 = ay \times ay$

But $ay \times ay = ayay = aayy = a^2y^2$ *Ans*

In finding the power of a *product*, therefore, we may either involve the *whole* at *once*, or we may involve *each* of the factors *separately*, and then multiply their several powers into each other

181. *When the root is positive, all its powers are positive also; but when the root is negative, the* odd *powers are negative, while the* even *powers are positive*

Hence any *odd* power has the same sign as its root But an *even* power is positive, whether its root is positive or negative Thus $(+a) \times (+a) = a^2$ And $(-a) \times (-a) = a^2$

182 To involve a quantity which is already a power

Rule —*Multiply the index of the quantity by the index of the power to which it is to be raised*

Example —Find the 3rd power of a^2. Here, $(a^2)^3 = a^6$

For $a^2 = aa$: and the cube of aa is $aa \times aa \times aa = aaaaaa = a^6$; which is the 6th power of a, but the 3rd power of a^2

Exercise 31

1 Required the 3rd power of $3x$
2 Required the 4th power of $4y$
3. Required the 7th power of $2a$
4 What is the 3rd power of bmx?
5 What is the nth power of ady?
6 What is the 4th power of dhy?
7 What is the 3rd power of $4b$?
8 What is the nth power of $6ad$?
9 What is the 3rd power of $3m \times 2y$?
10 Find the 4th power of a^3b^2
11 Find the 3rd power of $4a^2x$
12 Find the 4th power of $2a^3 \times 3x^2d$
13 Required the 5th power of $(a+b)^2$
14 Required the 2nd power of $(a+b)^n$
15 Required the nth power of $(x-y)^m$
16 Required the nth power of $(x+y)^2$
17 Required the 2nd power of $(a^3 \times b^3)$
18 Find the 3rd power of $(a^3b^2h^4)$

183 *A fraction is raised to a power by involving both the numerator and the denominator to the power required*

Example —Find the square of $\frac{a}{b}$

By the rule for the multiplication of fractions we have $\frac{a}{b} \times \frac{a}{b} = \frac{aa}{bb} = \frac{a^2}{b^2}$ *Ans*

184 A compound quantity, consisting of terms connected by $+$ and $-$, is involved by an actual multiplication of its several parts

Example —Find the 2nd, 3rd, and 4th powers of $a + b$

$$
\begin{aligned}
&\text{Here, } (a+b)^1 = a + b, \quad \ldots \quad \text{the first power;} \\
&\qquad\qquad a + b \\
&\qquad\qquad \overline{a^2 + ab} \\
&\qquad\qquad\qquad + ab + b^2 \\
&(a+b)^2 = \overline{a^2 + 2ab + b^2}, \text{ the second power,} \\
&\qquad\qquad a + b \\
&\qquad\qquad \overline{a^3 + 2a^2b + ab^2} \\
&\qquad\qquad\qquad + a^2b + 2ab^2 + b^3 \quad [\text{power,} \\
&(a+b)^3 = \overline{a^3 + 3a^2b + 3ab^2 + b^3}, \text{ the third} \\
&\qquad\qquad a + b \\
&\qquad\qquad \overline{a^4 + 3a^3b + 3a^2b^2 + ab^3} \\
&\qquad\qquad\qquad + a^3b + 3a^2b^2 + 3ab^3 + b^4 \\
&(a+b)^4 = \overline{a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4},
\end{aligned}
$$

the fourth power

Exercise 32

1 Find the 2nd, 3rd, and nth powers of $\frac{1}{a}$
2 Find the cube of $\frac{2r^2}{3y}$
3 Find the nth power of $\frac{x^2r}{ay^m}$
4 Find the square of $\frac{-a^3 \times (d+m)}{(x+1)^2}$
5. Find the square of $a - b$
6 Find the cube of $a + 1$
7 Find the square of $a + b + h$
8 Required the square of $a + 2d + 3$
9 Required the 4th power of $b + 2$.
10 Required the 5th power of $x + 1$.
11 Required the 6th power of $1 - b$

185 The squares of *binomial* and *residual* quantities occur so frequently in algebraic processes, that it is important to make them familiar Thus

If we multiply $a + h$ into itself, and also $a - h$ into itself, we have

$$
\begin{array}{ll}
a + h & a - h \\
\underline{a + h} & \underline{a - h} \\
a^2 + ah & a^2 - ah, \\
\underline{\quad + ah + h^2} & \underline{\quad - ah + h^2} \\
a^2 + 2ah + h^2 & a^2 - 2ah + h^2.
\end{array}
$$

Here it will be seen, that in each case the first and last terms are the squares of a and h; and that the middle term is twice the product of a by h. Hence the squares of binomial and residual quantities, without multiplying each of the terms separately, may be found by the following rule:—

(1) *The square of a* BINOMIAL, *the terms of which are both positive, is equal to the squares of the first and last terms, plus twice the product of the two terms.*

(2) *The square of a* RESIDUAL *quantity is equal to the squares of the first and last terms, minus twice the product of the two terms.*

Exercise 33.

1. Find the square of $2a + b$.
2. Find the square of $h + 1$.
3. Find the square of $ab + cd$.
4. Find the square of $6y - 3$.
5. Find the square of $3d - h$.
6. Find the square of $a - 1$.

186. For many purposes it will be sufficient to express the powers of compound quantities by *exponents* without an actual multiplication.

Examples.

1. Find the square of $a + b$. *Ans.* $(a + b)^2$.

2. Find the nth power of $bc + 8 + x$. *Ans.* $(bc + 8 + x)^n$.

In cases of this kind, *all* the terms of which the compound quantity consists must be included in the parenthesis.

187. But if the root consists of several *factors*, the parenthesis used in expressing the power may either extend over the whole, or may be applied to each of the factors separately, as convenience may require.

Thus the square of $(a + b) \times (c + d)$, is either

$$\left\{ (a + b) \times (c + d) \right\}^2, \text{ or } (a + b)^2 \times (c + d)^2.$$

The first of these expressions is the square of the product of the two factors, and the last is the product of their squares, and these are equal to each other.

In like manner the cube of $a \times (b + d)$ is

$$\left\{ a \times (b + d) \right\}^3, \text{ or } a^3 \times (b + d)^3.$$

188. When a quantity whose power has been expressed by a parenthesis, with an index, is afterwards involved by an actual multiplication of the terms, it is said to be *expanded*.

Thus $(a + b)^2$, when expanded, becomes $a^2 + 2ab + b^2$, and $(a + b + h)^2$ becomes $a^2 + 2ab + 2ah + b^2 + 2bh + h^2$.

BINOMIAL THEOREM.

189. To involve a *binomial* to a *high power* by actual multiplication is a long and tedious process. A much easier and more expeditious way to obtain the required power is by means of what is called the *Binomial Theorem*. This ingenious and beautiful method was invented by Sir Isaac Newton, and was deemed of so great importance to mathematical investigation, that it was inscribed on his monument in Westminster Abbey

To illustrate this theorem, let the pupil involve the binomial $a + b$, and the residual $a - b$, to the 2nd, 3rd, and 4th powers.

$$\begin{aligned}
\text{Thus, } (a + b)^2 &= a^2 + 2ab + b^2 \\
(a + b)^3 &= a^3 + 3a^2b + 3ab^2 + b^3. \\
(a + b)^4 &= a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4. \\
\text{Also, } (a - b)^2 &= a^2 - 2ab + b^2 \\
(a - b)^3 &= a^3 - 3a^2b + 3ab^2 - b^3 \\
(a - b)^4 &= a^4 - 4a^3b + 6a^2b^2 - 4ab^3 + b^4
\end{aligned}$$

By a careful inspection of the several parts of the preceding operation, the following particulars will be observed to be applicable to each power, especially if carried out to a greater number of powers.

1. By counting the terms, it will be found that the *number* in each power is *greater* by 1 than the *index* of that power; thus, in the 3rd power the number of terms is 4; in the 4th power it is 5, and so on.

2. If we examine the signs, we shall perceive, when both terms of the binomial are *positive*, that all the signs in every power are +; but when the quantity is a *residual*, all the *odd* terms, reckoning from the left, have the sign +, and all the *even* terms have the sign −. Thus in the 4th power, the signs of the *first*, *third*, and *fifth* terms are +, while those of the *second* and *fourth* are −.

3. As to the *indices*, it will be seen that the index of the first term, or the *leading quantity** in each power, always begins with the index of the *proposed power*, and *decreases* by 1 in each successive term towards the right, till we come to the last term, from which the letter itself is excluded. Thus, in $(a + b)^4$ the indices of the leading quantity a are 4, 3, 2, 1.

4. The index of the *following* quantity begins with 1 in the second term, and *increases* regularly by 1 to the *last* term, whose index, like that of the first, is the index of the *required power*. Thus, in $(a + b)^4$ the indices of the following quantity b are 1, 2, 3, 4.

5. We also perceive that the sum of the indices is the *same* in *each* term of any given power; and this sum is equal to the *index* of that power. Thus, the sum of the indices in each of the terms of the 4th power is 4.

* The first letter of a binomial is called the *leading* quantity, and the other the *following* quantity.

6. As to the *coefficients* of the several terms, that of the *first* and *last* terms in each power is 1; the coefficient of the *second* and *next* to the last terms is the *index* of the required power. Thus, in the 3rd power, the coefficient of the second and next to the last terms is 3; and in the same terms in the 4th power, it is 4, etc.

It is to be observed, also, that the coefficients *increase* in a regular manner through the *first half* of the terms, and then *decrease* at the same rate through the last half. Thus,

In the 4th power they are 1, 4, 6, 4, 1,

In the 6th power they are 1, 6, 15, 20, 15, 6, 1.

7. The coefficients of any two terms equally distant from the extremes, are *equal* to each other. Thus, in the 4th power, the second coefficient from each extreme is 4; in the 6th power, the second coefficient from each extreme is 6, and the third is 15.

8. The sum of all the coefficients in each power is equal to the number 2 raised to that power. Thus $(2)^4=16$; also, the sum of the coefficients in the 4th power is 16, and $(2)^6=64$; so the sum of the coefficients in the 6th power is 64.

190. If we involve *any other binomial, or residual, to any required power whatever,* we shall find the foregoing principles *true in all cases,* and applicable to all examples. Hence we may safely conclude that they are *universal principles,* and may be employed in raising all binomials to any required power. They are the *basis* or *elements* of what is called the *Binomial Theorem*.

The *Binomial Theorem* may be, therefore, defined as *a general method of involving binomial quantities to any proposed power.* It is comprised in the following general rule:—

1. SIGNS.—*If both terms of the binomial have the sign +, all the signs in every power will be +; but if the given quantity is a residual, all the odd terms in each power, reckoning from the left, will have the sign +, and the even terms —.*

2. INDICES.—*The index of the first term or leading quantity must always be the index of the required power; and this decreases regularly by 1 through the other terms. The index of the following quantity begins with 1 in the second term, and increases regularly by 1 through the others.*

3. COEFFICIENTS.—*The coefficient of the first term is 1; that of the second is equal to the index of the power; and, universally, if the coefficient of any term be multiplied by the index of the leading quantity in that term, and divided by the index of the following quantity increased by 1, it will give the coefficient of the succeeding term.*

4. NUMBER OF TERMS.—*The number of terms will always be 1 greater than the power required.*

In algebraic characters, the theorem is expressed thus—

$$(a+b)^n = a^n + na^{n-1}b + n.\frac{n-1}{2}a^{n-2}b^2 + n.$$
$$\frac{n-1}{2}.\ \frac{n-2}{3}a^{n-3}b^3 + \text{etc.}$$

It is here supposed that the *terms* of the binomial have no other coefficients or exponents than 1; but other binomials may be reduced to this form by substitution.

EXAMPLES.

1. What is the 6th power of $x+y$?

Here, the terms without the coefficients are x^6, x^5y, x^4y^2, x^3y^3, x^2y^4, xy^5, y^6. And the coefficients, by the rule, are

$$1,\ 6,\ \frac{6\times5}{2},\ \frac{15\times4}{3},\ \frac{20\times3}{4},\ 6,\ 1.$$

or 1, 6, 15, 20, 15, 6, 1.

Now, prefixing these coefficients to the several terms, and observing the rule of signs, we have the power required as follows:—

$x^6+6x^5y+15x^4y^2+20x^3y^3+15x^2y^4+6xy^5+y^6$. *Ans.*

2. What is the 5th power of x^2+3y^2?

Here, substituting a for x^2, and b for $3y^2$, we have $(a+b)^5 = a^5+5a^4b+10a^3b^2+10a^2b^3+5ab^4+b^5$.

And restoring the values of a and b, we have $(x^2+3y^2)^5 = x^{10}+15x^8y^2+90x^6y^4+270x^4y^6+405x^2y^8+243y^{10}$.

191. When one of the terms of a binomial is a *unit*, it is generally omitted in the power, except in the first or last term; because every power of 1 is 1; and this, when it is a factor, has no effect upon the quantity with which it is connected.

EXAMPLE.—Find the cube of $(x+1)$. *Ans.* $x^3+3x^2\times1+3x\times1^2+1^3$, or x^3+3x^2+3x+1.

192. The insertion of the powers of 1 is of no use, unless it be to preserve the *exponents* of both the leading and the following quantity in each term for the purpose of finding the coefficients. But this will be unnecessary if we bear in mind that the *sum* of the two exponents in each term is equal to the index of the power. So that, if we have the exponent of the *leading* quantity, we may know that of the *following* quantity, and *vice versâ*.

193. The binomial theorem may also be applied to quantities consisting of *more than two terms*. By substitution, several terms may be reduced to two; and when the compound expressions are restored, such of them as have exponents may be separately expanded.

EXAMPLE.—What is the cube of $a+b+c$?

Here, substituting h for $(b+c)$, we have $a+(b+c)=a+h$. And, by the theorem $(a+h)^3=a^3+3a^2h+3ah^2+h^3$.

Now, restoring the value of h, we have $(a+b+c)^3=a^3+3a^2\times(b+c)+3a\times(b+c)^2+(b+c)^3$.

The last two terms contain powers of $(b+c)$; but these may be separately involved, and the whole expanded.

194. Binomials, in which one of the terms is a fraction, may be involved by actual multiplication, or by reducing the given quantity to an improper fraction, and then involving the fraction. It may also be done by substitution.

EXAMPLES.—Find the squares of $x+\frac{1}{2}$; and of $x-\frac{1}{2}$.

$$\begin{array}{rl} \text{Here, } & x+\frac{1}{2} \\ & x+\frac{1}{2} \\ \hline & x^2+\frac{1}{2}x \\ & \quad +\frac{1}{2}x+\frac{1}{4} \\ \hline & x^2+x+\frac{1}{4} \end{array} \qquad \begin{array}{rl} \text{Also, } & x-\frac{1}{2} \\ & x-\frac{1}{2} \\ \hline & x^2-\frac{1}{2}x \\ & \quad -\frac{1}{2}x+\frac{1}{4} \\ \hline & x^2-x+\frac{1}{4}. \end{array}$$

Otherwise, reducing the mixed quantities to improper fractions, we have $x+\frac{1}{2}=\frac{2x+1}{2}$; and $x-\frac{1}{2}=\frac{2x-1}{2}$. Whence, $\left(\frac{2x+1}{2}\right)^2=\frac{4x^2+4x+1}{4}$; and $\left(\frac{2x-1}{2}\right)^2=\frac{4x^2-4x+1}{4}$, or $x^2+x+\frac{1}{4}$, and $x^2-x+\frac{1}{4}$, as before.

EXERCISE 34.

1. What is the 5th power of $(d+h)$?
2. What is the nth power of $(b+y)$?
3. What is the 6th power of $(3x+2y)$?
4. What is the 2nd power of $(a-b)$?
5. What is the 3rd power of $(a-b)$?
6. What is the 4th power of $(a-b)$?
7. What is the 6th power of $(x-y)$?
8. What is the nth power of $(a-b)$?
9. What is the 4th power of $(a-1)$?
10. What is the 6th power of $(1-y)$?
11. What is the nth power of $(1+x)$?
12. Find the square of $a+\frac{2}{3}$.
13. Find the square of $x-\frac{b}{2}$.
14. Find the square of $-\frac{b}{m}+3xy$.
15. Find the square of $-\frac{6}{7}+2abc$.

EXERCISE 35.

1. Expand $(x+y)^5$.
2. Expand $(a+b)^4$.
3. Expand $(a-b)^6$.
4. Expand $(x+y)^7$.
5. Expand $(x-y)^6$.
6. Expand $(m+n)^7$.
7. Expand $(a+b)^9$.
8. Expand $(x+y)^{10}$.
9. Expand $(x-y)^{12}$.
10. Expand $(a-b)^7$.
11. Expand $(a+b)^8$.
12. Expand $(2-x)^5$.
13. Expand $(a-b+c)^3$.
14. Expand $(a+3b)^3$
15. Expand $(2ab-x)^4$.
16. Expand $(4ab+5x^2)^4$.
17. Expand $(3x-5y)^4$.
18. Expand $(5a+3d)^5$.

KEY TO EXERCISES.

EXERCISE 28.

1. $x=104$.
2. $x=3,275$.
3. $x=\frac{(bc-a)(m+n)}{c}$.
4. $x=\frac{(abc-d)(l-m-n)}{c}$.
5. $x=mal+\frac{ma}{b+c+d}$
6. $x=8$.
7. $x=\frac{abc(d-h)}{ab-ac+bc}$
8. $x=12$.
9. $x=23\frac{1}{5}$.
10. $x=25$[illegible].
11. $x=\frac{1}{6}(1-a)$.
12. $x=-3\frac{1}{15}$.
13. $x=\frac{4}{5}$
14. $x=6$.
15. $x=1\frac{1}{5}$.
16. $x=9$.
17. $x=7$.
18. $x=4$.
19. $x=9$.
20. $x=7$.
21. $x=1$
22. $x=4$.
23. $x=6$.
24. $x=4$.
25. $x=2$.
26. $x=45$.
27. $x=23$.
28. $x=12$.
29. $x=40$.
30. $x=19$.
31. $x=51$.
32. $x=420$.
33. $x=11$.

EXERCISE 29.

1. 7 and 4.
2. 5, 8, 2, 24.
3. 48.
4. £4,800.
5. 450.
6. 240 and 200.
7. 210 miles from London.
8. $200\frac{1}{13}$ miles from London.
9. 16, 32, and 12.
10. £116 13s. 4d and £93 6s. 8d.
11. £1,000.
12. 45 and 15 years.
13. A's share, £416 13s. 4d; B's, £266 13s. 4d.; and C's, £316 13s. 4d.
14. 30.
15. 5,040.
16. 25 and 19.
17. 13

EXERCISE 30.

1. 9 and 19.
2. 17 and 31.
3. 13.
4. £180.
5. 864.
6. 21 and 16.
7. 9 and 3 years.
8. 12 hours.
9. 6 and 9
10. 156 days
11. £1,200.
12. 8.
13. $32\frac{1}{2}$ miles.
14. 480.
15. £1,125 and £875.
16. £120
17. A 200 miles, and B 160 miles.
18. 48 years.
19. 1,920.
20. 35.
21. 100.
22. 800 trees
23. 47.
24. £280.
25. 84 years.
26. 84.
27. £450.
28. 147 lb.
29. 29 gals. brandy, 44 gals wine, and 73 gals. water.
30. A, £317; B, £951; C, £1,268; and D, £2,219.
31. 17, 14, 27, 8, and 33.
32. 153 shillings.
33. 147 sheep.
34. 20 days.
35. A, 84; B, 42; C, 14
36. 20 yards and 26 yards.
37. £320.
38. 12.
39. Chaise, £240; horse, £80; harness, £40.
40. 126 gallons
41. 10, 14, 18, 22, 26, and 30
42. 30 and 19
43. 16 and 24.
44. 36 and 12.
45. 42 and 28.
46. 12, 4, and 18 miles.
47. 8, 12, and 16.
48. £740.
49. 24,000 men.
50. 53
51. 23.
52. $\frac{5}{17}$
53. 20 and 13.
54. 233 and 142.
55. 24 feet
56. 10 shillings.
57. 18 years.
58. 54 years
59. 21 years.
60. $0\frac{1}{4}$.
61. 56 hours.
62. 20 days.
63. 197 sheep.
64. 6 days.
65. 30 days.
66. 120 minutes
67. 36 farthings and 3 pence.
68. 5 shares and 120 pence
69. 300 leaps.
70. 60 days; and 1,800 and 1,200 miles for A and B respectively
71. £44 from B, and £88 from A
72. A, £312; B, £412, and C, £476.
73. 12s., 2s., 16s.
74. $5\frac{1}{2}$ hours
75. 20s.
76. [illegible]
77. [illegible]
78. £60 and £80.

FRENCH.—XXVI.

[Continued from p. 38.]

ALPHABETICAL TABLE

OF THE IRREGULAR, DEFECTIVE, PECULIAR, AND IMPERSONAL VERBS (*continued*).

The figures placed after the infinitive of the verbs indicate the conjugations to which they belong. The tenses not given in this Table are not used.

Infinitive.	Participles.	Indicative. Present.	Indicative. Imperfect.	Indicative. Past Definite.	Indicative. Future.	Conditional Present.	Imperative.	Subjunctive. Present.	Subjunctive. Imperfect.
INSTRUIRE, 4, *to instruct*	instruisant instruit, *f.* -e	j'instruis see CONDUIRE	j'instruisais	j'instruisis	j'instruirai	j'instruirais	instruis	j'instruise	j'instruisisse
INTERDIRE, 4, *to interdict*	interdisant interdit, *f.* -e	j'interdis see CONTREDIRE	j'interdisais	j'interdis	j'interdirai	j'interdirais	interdis	j'interdise	j'interdisse
INTERROMPRE, 4, *to interrupt*	interrompant interrompu, *f.* -e	j'interromps see ROMPRE	j'interrompais	j'interrompis	j'interromprai	j'interromprais	interromps	j'interrompe	j'interrompisse
INTERVENIR, 2, *to intervene*	intervenant intervenu, *f.* -e	j'interviens see TENIR	j'intervenais	j'intervins	j'interviendrai	j'interviendrais	interviens	j'intervienne	j'intervinsse
INTRODUIRE, 4, *to introduce*	introduisant introduit, *f.* -e	j'introduis see CONDUIRE	j'introduisais	j'introduisis	j'introduirai	j'introduirais	introduis	j'introduise	j'introduisisse
JETER, 1, *to throw* aux. avoir peculiar	jetant jeté, *f.* -e	je jette tu jettes il jette n. jetons v. jetez ils jettent	je jetais tu jetais il jetait n. jetions v. jetiez ils jetaient	je jetai tu jetas il jeta n. jetâmes v. jetâtes ils jetèrent	je jetterai tu jetteras il jettera n. jetterons v. jetterez ils jetteront	je jetterais tu jetterais il jetterait n. jetterions v. jetteriez ils jetteraient	jette qu'il jette jetons jetez q. i. jettent	je jette tu jettes il jette n. jetions v. jetiez ils jettent	je jetasse tu jetasses il jetât n. jetassions v. jetassiez ils jetassent
JOINDRE, 4, *to join*	joignant joint, *f.* -e	je joins see CRAINDRE	je joignais	je joignis	je joindrai	je joindrais	joins	je joigne	je joignisse
LIRE, 4, *to read* aux. avoir irregular	lisant lu, *f.* -e	je lis tu lis il lit nous lisons vous lisez ils lisent	je lisais tu lisais il lisait n. lisions v. lisiez ils lisaient	je lus tu lus il lut n. lûmes v. lûtes ils lurent	je lirai tu liras il lira n. lirons v. lirez ils liront	je lirais tu lirais il lirait n. lirions v. liriez ils liraient	lis qu'il lise lisons lisez q. i. lisent	je lise tu lises il lise n. lisions v. lisiez ils lisent	je lusse tu lusses il lût n. lussions v. lussiez ils lussent
LUIRE, 4, *to shine*	luisant lui	je luis see CONDUIRE	je luisais		je luirai	je luirais		je luise	
MAINTENIR, 2, *to maintain*	maintenant maintenu, *f.* -e	je maintiens see TENIR	je maintenais	je maintins	je maintiendrai	je maintiendrais	maintiens	je maintienne	je maintinsse
MALFAIRE, 4, *to do wrong*	malfaisant malfait, *f.* -e	*seldom used*	*except in the tenses*	*given here*					
MAUDIRE, 4, *to curse*	maudissant maudit, *f.* -e	je maudis tu maudis il maudit n. maudissons v. maudissez i. maudissent	je maudissais tu maudissais il maudit n. maudissions v. maudissiez i. maudissaient	je maudis *like* DIRE	je maudirai *like* DIRE	je maudirais *like* DIRE	maudis q. i. maudisse maudissons maudissez q. i. maudissent	je maudisse tu maudisses il maudisse n. maudissions v. maudissiez ils maudissent	je maudisse *like* DIRE
MÉCONNAÎTRE, 4, *to disown*	méconnaissant méconnu, *f.* -e	je méconnais see CONNAÎTRE	je méconnaissais	je méconnus	je méconnaîtrai	je méconnaîtrais	méconnais	je méconnaisse	je méconnusse
MÉDIRE, 4, *to slander*	médisant médit	je médis see CONTREDIRE	je médisais	je médis	je médirai	je médirais	médis	je médise	je médisse
MÉFAIRE,* 4, *to do wrong*	méfaisant méfait	je méfais see FAIRE	je méfaisais	je méfis	je méferai	je méferais	méfais	je méfasse	je méfisse

* This verb is very seldom used.

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MENER, 1, *to lead, take to*	menant mené, *f.* -e	je mène	je menais	je menai	je mènerai	je mènerais	mène	je mène	je menasse
MENTIR, 1, *to lie*	mentant menti	je mens *see* SENTIR	je mentais	je mentis	je mentirai	je mentirais	mens	je mente	je mentisse
MÉPRENDRE(SE), 4, *to mistake*, reflective	se méprenant mépris, *f.* -e	je me méprends *see* PRENDRE	je me méprenais	je me mépris	je me méprendrai	je me méprendrais	méprends-toi	je me méprenne	je me méprisse
METTRE, 4, *to put* aux. avoir irregular	mettant mis, *f.* -e	je mets tu mets il met n. mettons v. mettez ils mettent	je mettais tu mettais il mettait n. mettions v. mettiez ils mettaient	je mis tu mis il mit n. mîmes v. mîtes ils mirent	je mettrai tu mettras il mettra n. mettrons v. mettrez ils mettront	je mettrais tu mettrais il mettrait n. mettrions v. mettriez ils mettraient	mets qu'il mette mettons mettez q. i. mettent	je mette tu mettes il mette n. mettions v. mettiez ils mettent	je misse tu misses il mît n. missions v. missiez ils missent
MOUDRE, 4, *to grind* aux. avoir irregular	moulant moulu, *f.* -e	je mouds tu mouds il moud n. moulons v. moulez ils moulent	je moulais tu moulais il moulait n. moulions v. mouliez ils moulaient	je moulus tu moulus il moulut n. moulûmes v. moulûtes ils moulurent	je moudrai tu moudras il moudra n. moudrons v. moudrez ils moudront	je moudrais tu moudrais il moudrait n. moudrions v. moudriez i. moudraient	mouds qu'il moule moulons moulez q. i. moulent	je moule tu moules il moule n. moulions v. mouliez ils moulent	je moulusse tu moulusses il moulût n. moulussions v. moulussiez ils moulussent
MOURIR, 2, *to die* aux. être irregular	mourant mort, *f.* -e	je meurs tu meurs il meurt n. mourons v. mourez ils meurent	je mourais tu mourais il mourait n. mourions v. mouriez ils mouraient	je mourus tu mourus il mourut n. mourûmes v. mourûtes ils moururent	je mourrai tu mourras il mourra n. mourrons v. mourrez ils mourront	je mourrais tu mourrais il mourrait n. mourrions v. mourriez ils mourraient	meurs qu'il meure mourons mourez q. i. meurent	je meure tu meures il meure n. mourions v. mouriez ils meurent	je mourusse tu mourusses il mourût n. mourussions v. mourussiez ils mourussent
MOUVOIR, 3, *to move* aux. avoir irregular	mouvant mu, *f.* -e	je meus tu meus il meut n. mouvons v. mouvez ils meuvent	je mouvais tu mouvais il mouvait n. mouvions v. mouviez ils mouvaient	je mus tu mus il mut n. mûmes v. mûtes ils murent	je mouvrai tu mouvras il mouvra n. mouvrons v. mouvrez ils mouvront	je mouvrais tu mouvrais il mouvrait n. mouvrions v. mouvriez ils mouvraient	meus qu'il meuve mouvons mouvez q. i. meuvent	je meuve tu meuves il meuve n. mouvions v. mouviez ils meuvent	je musse tu musses il mût n. mussions v. mussiez ils mussent
NAITRE, 4, *to be born* aux. être irregular	naissant né, *f.* -e	je nais tu nais il naît n. naissons v. naissez ils naissent	je naissais tu naissais il naissait n. naissions v. naissiez ils naissaient	je naquis tu naquis il naquit n. naquîmes v. naquîtes ils naquirent	je naîtrai tu naîtras il naîtra n. naîtrons v. naîtrez ils naîtront	je naîtrais tu naîtrais il naîtrait n. naîtrions v. naîtriez ils naîtraient	nais qu'il naisse naissons naissez q. i. naissent	je naisse tu naisses il naisse n. naissions v. naissiez ils naissent	je naquisse tu naquisses il naquît n. naquissions v. naquissiez ils naquissent
NÉGLIGER, 1, *to neglect*	négligeant négligé, *f.* -e	je néglige	je négligeais	je négligeai	je négligerai	je négligerais	néglige	je néglige	je négligeasse
NEIGER, 1, *to snow*, imp.	neigeant neigé	il neige	il neigeait	il neigea	il neigera	il neigerait		qu'il neige	q. i. neigeât
NIVELER, 1, *to level*	nivelant nivelé, *f.* -e	je nivelle *see* APPELER	je nivelais	je nivelai	je nivellerai	je nivellerais	nivelle	je nivelle	je nivelasse
NUIRE, 4, *to injure*	nuisant nui	je nuis *see* CONDUIRE	je nuisais	je nuisis	je nuirai	je nuirais	nuis	je nuise	je nuisisse
OBTENIR, 2, *to obtain*	obtenant obtenu, *f.* -e	j'obtiens *see* TENIR	j'obtenais	j'obtins	j'obtiendrai	j'obtiendrais	obtiens	j'obtienne	j'obtinsse
OFFRIR, 2, *to offer*	offrant offert, *f.* -e	j'offre *see* OUVRIR	j'offrais	j'offris	j'offrirai	j'offrirais	offre	j'offre	j'offrisse
OINDRE, 4, *to anoint*	oignant oint, *f.* -e	j'oins *see* CEINDRE	j'oignais	j'oignis	j'oindrai	j'oindrais	oins	j'oigne	j'oignisse
OMETTRE, 4, *to omit*	omettant omis, *f.* -e	j'omets *see* METTRE	j'omettais	j'omis	j'omettrai	j'omettrais	omets	j'omette	j'omisse
OUÏR, 2, *to hear*, reflective	oyant ouï, *f.* -e	j'ois tu ois il oit n. oyons v. oyez ils oient	j'oyais, etc.	j'ouïs, etc.	j'ouïrai	j'ouïrais	oyez	j'oie, *or* j'oye	j'ouïsse

Infinitive.	Participles.	Indicative.				Conditional Present.	Imperative.	Subjunctive.	
		Present.	Imperfect.	Past Definite.	Future.			Present.	Imperfect.
OUVRIR, 2, *to open* aux. avoir irregular	ouvrant ouvert, *f.* -e	j'ouvre tu ouvres il ouvre n. ouvrons v. ouvrez ils ouvrent	j'ouvrais tu ouvrais il ouvrait n. ouvrions v. ouvriez ils ouvraient	j'ouvris tu ouvris il ouvrit n. ouvrîmes v. ouvrîtes ils ouvrirent	j'ouvrirai tu ouvriras il ouvrira n. ouvrirons v. ouvrirez ils ouvriront	j'ouvrirais tu ouvrirais il ouvrirait n. ouvririons v. ouvririez ils ouvriraient	ouvre qu'il ouvre ouvrons ouvrez q. l. ouvrent	j'ouvre tu ouvres il ouvre n. ouvrions v. ouvriez ils ouvrent	j'ouvrisse tu ouvrisses il ouvrît n. ouvrissions v. ouvrissiez ils ouvrissent
PAÎTRE, 4, *to graze* aux. avoir defective	paissant pu	je pais tu pais il paît n. paissons v. paissez ils paissent	je paissais tu paissais il paissait n. paissions v. paissiez ils paissaient		je paîtrai tu paîtras il paîtra n. paîtrons v. paîtrez ils paîtront	je paîtrais tu paîtrais il paîtrait n. paîtrions v. paîtriez ils paîtraient	pais qu'il paisse paissons paissez q. l. paissent	je paisse tu paisses il paisse n. paissions v. paissiez ils paissent	
PARAÎTRE, 4, *to appear*	paraissant paru	je parais *see* CONNAÎTRE	je paraissais	je parus	je paraîtrai	je paraîtrais	parais	je paraisse	je parusse
PARCOURIR, 2, *to go through*	parcourant parcouru, *f.* -e	je parcours *see* COURIR	je parcourais	je parcourus	je parcourrai	je parcourrais	parcours	je parcoure	je parcourusse
PARFAIRE, 4, *to complete*	parfaisant parfait, *f.* -e	je parfais *see* FAIRE	je parfaisais *seldom used*	je parfis	je parferai	je parferais	parfais	je parfasse	je parfisse
PARTIR, 2, *to depart*	partant parti, *f.* -e	je pars *see* SENTIR	je partais	je partis	je partirai	je partirais	pars	je parte	je partisse
PARVENIR, 2, *to succeed, etc.*	parvenant parvenu, *f.* -e	je parviens *see* TENIR	je parvenais	je parvins	je parviendrai	je parviendrais	parviens	je parvienne	je parvinsse
PAYER, 1, *to pay*	payant payé, *f.* -e	je paye *see* ESSAYER	je payais	je payai	je payerai	je payerais	paye	je paye	je payasse
PEINDRE, 4, *to paint*	peignant peint, *f.* -e	je peins *see* CEINDRE	je peignais	je peignis	je peindrai	je peindrais	peins	je peigne	je peignisse
PELER, 1, *to peel*	pelant pelé, *f.* -e	je pèle	je pelais	je pelai	je pèlerai	je pèlerais	pèle	je pèle	je pelasse
PERMETTRE, 4, *to permit*	permettant permis, *f.* -e	je permets *see* METTRE	je permettais	je permis	je permettrai	je permettrais	permets	je permette	je permisse
PLAINDRE, 1, *to pity*	plaignant plaint, *f.* -e	je plains *see* CEINDRE	je plaignais	je plaignis	je plaindrai	je plaindrais	plains	je plaigne	je plaignisse
PLAIRE, 4, *to please* aux. avoir irregular	plaisant plu	je plais tu plais il plaît n. plaisons v. plaisez ils plaisent	je plaisais tu plaisais il plaisait n. plaisions v. plaisiez ils plaisaient	je plus tu plus il plut n. plûmes v. plûtes ils plurent	je plairai tu plairas il plaira n. plairons v. plairez ils plairont	je plairais tu plairais il plairait n. plairions v. plairiez ils plairaient	plais qu'il plaise plaisons plaisez q. l. plaisent	je plaise tu plaises il plaise n. plaisions v. plaisiez ils plaisent	je plusse tu plusses il plût n. plussions v. plussiez ils plussent
PLEUVOIR, 3, *to rain*, imp.	pleuvant plu	il pleut	il pleuvait	il plut	il pleuvra	il pleuvrait		qu'il pleuve	qu'il plût
POINDRE, 4, *to dawn*, def.		il point			il poindra	il poindrait			
POURSUIVRE, 1, *to pursue*	poursuivant poursuivi, *f.* -e	je poursuis *see* SUIVRE	je poursuivais	je poursuivis	je poursuivrai	je poursuivrais	poursuis	je poursuive	je poursuivisse
POURVOIR, 3, *to provide* aux. avoir irregular	pourvoyant pourvu, *f.* -e	je pourvois tu pourvois il pourvoit n. pourvoyons v. pourvoyez ils pourvoient	je pourvoyais tu pourvoyais il pourvoyait n. pourvoyions v. pourvoyiez ils pourvoyaient	je pourvus tu pourvus il pourvut n. pourvûmes v. pourvûtes ils pourvurent	je pourvoirai tu pourvoiras il pourvoira n. pourvoirons v. pourvoirez ils pourvoiront	je pourvoirais tu pourvoirais il pourvoirait n. pourvoirions v. pourvoiriez ils pourvoiraient	pourvois q. l. pourvoie pourvoyons pourvoyez qu'ils pourvoient	je pourvoie tu pourvoies il pourvoie n. pourvoyions v. pourvoyiez ils pourvoient	je pourvusse tu pourvusses il pourvût n. pourvussions v. pourvussiez ils pourvussent
POUVOIR, 3, *to be able* aux. avoir irregular	pouvant pu	je puis, peux tu peux il peut n. pouvons v. pouvez ils peuvent	je pouvais tu pouvais il pouvait n. pouvions v. pouviez ils pouvaient	je pus tu pus il put n. pûmes v. pûtes ils purent	je pourrai tu pourras il pourra n. pourrons v. pourrez ils pourront	je pourrais tu pourrais il pourrait n. pourrions v. pourriez ils pourraient		je puisse tu puisses il puisse n. puissions v. puissiez ils puissent	je pusse tu pusses il pût n. pussions v. pussiez ils pussent

PRÉDIRE, 4, *to predict*	prédisant prédit, *f.* -e	je prédis *see* CONTREDIRE	je prédisais	je prédis	je prédirai	je prédirais	prédis	je prédise	je prédisse
PRENDRE, 1, *to take* aux. avoir irregular	prenant pris, *f.* -e	je prends tu prends il prend n. prenons v. prenez ils prennent	je prenais tu prenais il prenait n. prenions v. preniez ils prenaient	je pris tu pris il prit n. prîmes v. prîtes ils prirent	je prendrai tu prendras il prendra n. prendrons v. prendrez ils prendront	je prendrais tu prendrais il prendrait n. prendrions v. prendriez ils prendraient	prends qu'il prenne prenons prenez q. i. prennent	je prenne tu prennes il prenne n. prenions v. preniez il prennent	je prisse tu prisses il prît n. prissions v. prissiez ils prissent
PRESCRIRE, 1, *to prescribe*	prescrivant prescrit, *f.* -e	je prescris *see* ÉCRIRE	je prescrivais	je prescrivis	je prescrirai	je prescrirais	prescris	je prescrive	je prescrivisse
PRESSENTIR, 2, *to foresee*	pressentant pressenti, *f.* -e	je pressens *see* SENTIR	je pressentais	je pressentis	je pressentirai	je pressentirais	pressens	je pressente	je pressentisse
PRÉVALOIR, 3, *to prevail*	prévalant prévalu	je prévaux *see* VALOIR	je prévalais	je prévalus	je prévaudrai	je prévaudrais	prévaux	je prévale	je prévalusse
PRÉVENIR, 2, *to prevent*	prévenant prévenu, *f.* -e	je préviens *see* TENIR	je prévenais	je prévins	je préviendrai	je préviendrais	préviens	je prévienne	je prévinsse
PRÉVOIR, 3, *to foresee*	prévoyant prévu, *f.* -e	je prévois *like* VOIR	je prévoyais *like* VOIR	je prévis *like* VOIR	je prévoirai *like* POURVOIR	je prévoirais *like* POURVOIR	prévois	je prévoie *like* VOIR	je prévisse *like* VOIR
PRODUIRE, 1, *to produce*	produisant produit, *f.* -e	je produis *see* CONDUIRE	je produisais	je produisis	je produirai	je produirais	produis	je produise	je produisisse
PROJETER, 1, *to project*	projetant projeté, *f.* -e	je projette *see* JETER	je projetais	je projetai	je projetterai	je projetterais	projette	je projette	je projetasse
PROMETTRE, 1, *to promise*	promettant promis, *f.* -e	je promets *see* METTRE	je promettais	je promis	je promettrai	je promettrais	promets	je promette	je promisse
PROMOUVOIR, 3, *to promote*	promu, *f.* -e								
PROSCRIRE, 4, *to proscribe*	proscrivant proscrit, *f.* -e	je proscris *see* ÉCRIRE	je proscrivais	je proscrivis	je proscrirai	je proscrirais	proscris	je proscrive	je proscrivisse
PROVENIR, 2, *to proceed.*	provenant provenu, *f.* -e	je proviens	je provenais	je provins	je proviendrai	je proviendrais	proviens	je provienne	je provinsse
QUÉRIR, 2, *to fetch.*									
RABATTRE, 1, *to abate*	rabattant rabattu, *f.* -e	je rabats *see* BATTRE	je rabattais	je rabattis	je rabattrai	je rabattrais	rabats	je rabatte	je rabattisse
RACHETER, 1, *to buy again*	rachetant racheté, *f.* -e	je rachète *see* ACHETER	je rachetais	je rachetai	je rachèterai	je rachèterais	rachète	je rachète	je rachetasse
RAPPELER, 1, *to recall*	rappelant rappelé, *f.* -e	je rappelle *see* APPELER	je rappelais	je rappelai	je rappellerai	je rappellerais	rappelle	je rappelle	je rappelasse
RAPPRENDRE, 1, *to learn again*	rapprenant rappris, *f.* -e	je rapprends *see* PRENDRE	je rapprenais	je rappris	je rapprendrai	je rapprendrais	rapprends	je rapprenne	je rapprisse
RATTEINDRE, 1, *to reach again*	ratteignant ratteint, *f.* -e	je ratteins *see* CEINDRE	je ratteignais	je ratteignis	je ratteindrai	je ratteindrais	ratteins	je ratteigne	je ratteignisse
REBATTRE, 1, *to beat again*	rebattant rebattu, *f.* -e	je rebats *see* BATTRE	je rebattais	je rebattis	je rebattrai	je rebattrais	rebats	je rebatte	je rebattisse
RECONDUIRE, 4, *to conduct again*	reconduisant reconduit, *f.* -e	je reconduis *see* CONDUIRE	je reconduisais	je reconduisis	je reconduirai	je reconduirais	reconduis	je reconduise	je reconduisisse
RECONNAÎTRE, 4, *to recognise*	reconnaissant reconnu, *f.* -e	je reconnais *see* CONNAÎTRE	je reconnaissais	je reconnus	je reconnaîtrai	je reconnaîtrais	reconnais	je reconnaisse	je reconnusse
RECONQUÉRIR, 2, *to conquer again*	reconquérant reconquis, *f.* -e	je reconquiers *see* ACQUÉRIR	je reconquérais	je reconquis	je reconquerrai	je reconquerrais	reconquiers	je reconquière	je reconquisse
RECONSTRUIRE, 4, *to reconstruct*	reconstruisant reconstruit, *f.* -e	je reconstruis *see* CONDUIRE	je reconstruisais	je reconstruisis	je reconstruirai	je reconstruirais	reconstruis	je reconstruise	je reconstruisisse
RECOUDRE, 1, *to sew again*	recousant recousu, *f.* -e	je recouds	je recousais	je recousis	je recoudrai	je recoudrais	recouds	je recouse	je recousisse
RECOURIR, 2, *to have recourse*	recourant recouru	je recours *see* COURIR	je recourais	je recourus	je recourrai	je recourrais	recours	je recoure	je recourusse
RECOUVRIR, 2, *to cover again*	recouvrant recouvert, *f.* -e	je recouvre *see* OUVRIR	je recouvrais	je recouvris	je recouvrirai	je recouvrirais	recouvre	je recouvre	je recouvrisse

Infinitive.	Participles.	Indicative. Present.	Indicative. Imperfect.	Indicative. Past Definite.	Indicative. Future.	Conditional Present.	Imperative.	Subjunctive. Present.	Subjunctive. Imperfect.
RECUEILLIR, 2, *to reap*	recueillant recueilli, *f.* -e	je recueille *see* CUEILLIR	je recueillais	je recueillis	je recueillerai	je recueillerais	recueille	je recueille	je recueillisse
REDIRE, 4, *to say again*	redisant redit, *f.* -e	je redis *see* DIRE	je redisais	je redis	je redirai	je redirais	redis	je redise	je redisse
RÉDUIRE, 4, *to reduce*	réduisant réduit, *f.* -e	je réduis *see* CONDUIRE	je réduisais	je réduisis	je réduirai	je réduirais	réduis	je réduise	je réduisisse
REFAIRE, 4, *to make again*	refaisant refait, *f.* -e	je refais *see* FAIRE	je refaisais	je refis	je referai	je referais	refais	je refasse	je refisse
REJOINDRE, 4, *to rejoin*	rejoignant rejoint, *f.* -e	je rejoins *see* CEINDRE	je rejoignais	je rejoignis	je rejoindrai	je rejoindrais	rejoins	je rejoigne	je rejoignisse
RELIRE, 4, *to read again*	relisant relu, *f.* -e	je relis *see* LIRE	je relisais	je relus	je relirai	je relirais	relis	je relise	je relusse
RELUIRE, 4, *to shine*	reluisant relui	je reluis *see* LUIRE	je reluisais		je reluirai	je reluirais	reluis	je reluise	
REMETTRE, 4, *to remit*	remettant remis, *f.* -e	je remets *see* METTRE	je remettais	je remis	je remettrai	je remettrais	remets	je remette	je remisse
REMOUDRE, 4, *to grind again*	remoulant remoulu, *f.* -e	je remouds *see* MOUDRE	je remoulais	je remoulus	je remoudrai	je remoudrais	remouds	je remoule	je remoulusse
RENAÎTRE, 4, *to revive*	renaissant rené, *f.* e	je renais *see* NAÎTRE	je renaissais	je renaquis	je renaîtrai	je renaîtrais	renais	je renaisse	je renaquisse
RENDORMIR, 2, *to lull to sleep*	rendormant rendormi, *f.* -e	je rendors *see* DORMIR	je rendormais	je rendormis	je rendormirai	je rendormirais	rendors	je rendorme	je rendormisse
RENTRAIRE, 4, *to darn*	rentrayant rentrait, *f.* -e	je rentrais *see* TRAIRE	je rentrayais		je rentrairai	je rentrairais	rentrais	je rentraie	
RENVOYER, 1, *to send back*	renvoyant renvoyé, *f.* -e	je renvoie *see* ENVOYER	je renvoyais	je renvoyai	je renverrai	je renverrais	renvoie	je renvoie	je renvoyasse
REPAÎTRE, 4, *to feed*	repaissant repu	je repais *see* PAÎTRE	je repaissais	je repus	je repaîtrai	je repaîtrais	repais	je repaisse	je repusse
REPARTIR, 2, *to set off again*	repartant reparti, *f.* -e	je repars *see* SENTIR	je repartais	je repartis	je repartirai	je repartirais	repars	je reparte	je repartisse
REPEINDRE, 4, *to paint again*	repeignant repeint, *f.* -e	je repeins *see* CEINDRE	je repeignais	je repeignis	je repeindrai	je repeindrais	repeins	je repeigne	je repeignisse
REPENTIR (SE), 4, *to repent*, reflective	se repentant repenti, *f.* -e	je me repens *see* SENTIR	je me repentais	je me repentis	je me repentirai	je me repentirais	repens-toi	je me repente	je me repentisse
REPRENDRE, 4, *to take again*	reprenant repris, *f.* -e	je reprends *see* PRENDRE	je reprenais	je repris	je reprendrai	je reprendrais	reprends	je reprenne	je reprisse
REPRODUIRE, 4, *to reproduce*	reproduisant reproduit, *f.* -e	je reproduis *see* CONDUIRE	je reproduisais	je reproduisis	je reproduirai	je reproduirais	reproduis	je reproduise	je reproduisisse
REQUÉRIR, 2, *to require*	requérant requis, *f.* -e	je requiers *see* ACQUÉRIR	je requérais	je requis	je requerrai	je requerrais	requiers	je requière	je requisse
RÉSOUDRE, 4, *to resolve*	résolvant résolu, résous	je résous *see* ABSOUDRE	je résolvais	je résolus	je résoudrai	je résoudrais	résous	je résolve	je résolusse
RESSENTIR, 2, *to resent*	ressentant ressenti, *f.* -e	je ressens *see* SENTIR	je ressentais	je ressentis	je ressentirai	je ressentirais	ressens	je ressente	je ressentisse
RESSORTIR, 2, *to go out again*	ressortant ressorti, *f.* -e	je ressors *see* SORTIR	je ressortais	je ressortis	je ressortirai	je ressortirais	ressors	je ressorte	je ressortisse
RESSOUVENIR (SE), 2, *to remember*, ref.	se ressouvenant ressouvenu, *f.* -e	je me ressouviens *see* TENIR	je me ressouvenais	je me ressouvins	je me ressouviendrai	je me ressouviendrais	ressouviens-toi	je me ressouvienne	je me ressouvinsse
RESTREINDRE, 4, *to restrain*	restreignant restreint, *f.* -e	je restreins *see* CEINDRE	je restreignais	je restreignis	je restreindrai	je restreindrais	restreins	je restreigne	je restreignisse
RETENIR, 2, *to retain*	retenant retenu, *f.* -e	je retiens *see* TENIR	je retenais	je retins	je retiendrai	je retiendrais	retiens	je retienne	je retinsse
RETRAIRE, 4, *to redeem*	retrayant retrait, *f.* -e	je retrais *see* TRAIRE	je retrayais		je retrairai	je retrairais	retrais	je retraie	

Revenir, 2, *to return*	revenant revenu, *f.* -e	je reviens see Venir	je revenais	je revins	je reviendrai	je reviendrais	reviens	je revienne	je revinsse
Revêtir, 2, *to clothe*	revêtant revêtu, *f.* -e	je revêts see Vêtir	je revêtais	je revêtis	je revêtirai	je revêtirais	revêts	je revête	je revêtisse
Revivre, 4, *to live again*	revivant revécu	je revis	je revivais	je revécus	je revivrai	je revivrais	revis	je revive	je revécusse
Revoir, 3, *to see again*	revoyant revu, *f.* -e	je revois see Voir	je revoyais	je revis	je reverrai	je reverrais	revois	je revoie	je revisse
Rire, 4, *to laugh* aux. avoir irregular	riant ri	je ris tu ris il rit n. rions v. riez ils rient	je riais tu riais il riait n. riions v. riiez ils riaient	je ris tu ris il rit n. rîmes v. rîtes ils rirent	je rirai tu riras il rira n. rirons v. rirez ils riront	je rirais tu rirais il rirait n. ririons v. ririez ils riraient	ris qu'il rie rions riez qu'ils rient	je rie tu ries il rie n. riions v. riiez ils rient	je risse tu risses il rît n. rissions v. rissiez ils rissent
Rompre, 4, *to break* aux. avoir irregular	rompant rompu, *f.* -e	je romps tu romps il rompt n. rompons v. rompez ils rompent	je rompais tu rompais il rompait n. rompions v. rompiez ils rompaient	je rompis tu rompis il rompit n. rompîmes v. rompîtes ils rompirent	je romprai tu rompras il rompra n. romprons v. romprez ils rompront	je romprais tu romprais il romprait n. romprions v. rompriez ils rompraient	romps qu'il rompe rompons rompez q. i. rompent	je rompe tu rompes il rompe n. rompions v. rompiez ils rompent	je rompisse tu rompisses il rompît n. rompissions v. rompissiez ils rompissent
Rouvrir, 2, *to re-open*	rouvrant rouvert, *f.* -e	je rouvre see Ouvrir	je rouvrais	je rouvris	je rouvrirai	je rouvrirais	rouvre	je rouvre	je rouvrisse
Saillir, 2, *to project*	saillant sailli	il saille ils saillent	il saillait ils saillaient	il saillit ils saillirent	il saillera ils sailleront	il saillerait ils sailleraient		il saille ils saillent	il saillît ils saillissent
Satisfaire, 4, *to satisfy*	satisfaisant satisfait, *f.* -e	je satisfais see Faire	je satisfaisais	je satisfis	je satisferai	je satisferais	satisfais	je satisfasse	je satisfisse
Savoir, 3, *to know* aux. avoir irregular	sachant su, *f.* -e	je sais tu sais il sait n. savons v. savez ils savent	je savais tu savais il savait n. savions v. saviez ils savaient	je sus tu sus il sut n. sûmes v. sûtes ils surent	je saurai tu sauras il saura n. saurons v. saurez ils sauront	je saurais tu saurais il saurait n. saurions v. sauriez ils sauraient	sache qu'il sache sachons sachez q. i. sachent	je sache tu saches il sache n. sachions v. sachiez ils sachent	je susse tu susses il sût n. sussions v. sussiez ils sussent
Secourir, 2, *to succour*	secourant secouru, *f.* -e	je secours see Courir	je secourais	je secourus	je secourrai	je secourrais	secours	je secoure	je secourusse
Séduire, 1, *to seduce*	séduisant séduit, *f.* -e	je séduis	je séduisais	je séduisis	je séduirai	je séduirais	séduis	je séduise	je séduisisse
Semer, 1, *to sow*, peculiar	semant semé, *f.* -e	je sème	je semais	je semai	je sèmerai	je sèmerais	sème	je sème	je semasse
Sentir, 2, *to feel* aux. avoir irregular	sentant senti, *f.* -e	je sens tu sens il sent n. sentons v. sentez ils sentent	je sentais tu sentais il sentait n. sentions v. sentiez ils sentaient	je sentis tu sentis il sentit n. sentîmes v. sentîtes ils sentirent	je sentirai tu sentiras il sentira n. sentirons v. sentirez ils sentiront	je sentirais tu sentirais il sentirait n. sentirions v. sentiriez ils sentiraient	sens qu'il sente sentons sentez q. i. sentent	je sente tu sentes il sente n. sentions v. sentiez ils sentent	je sentisse tu sentisses il sentît n. sentissions v. sentissiez ils sentissent
Seoir, 3, *to sit, to be situated*	séant sis, *f.* -e								
Seoir, 3, *to fit, become*	seyant	il sied ils siéent	il seyait ils seyaient		il siéra ils siéront	il siérait ils siéraient		il siée ils siéent	
Servir, 2, *to serve* irregular	servant servi, *f.* -e	je sers tu sers il sert n. servons v. servez ils servent	je servais tu servais il servait n. servions v. serviez ils servaient	je servis tu servis il servit n. servîmes v. servîtes ils servirent	je servirai tu serviras il servira n. servirons v. servirez ils serviront	je servirais tu servirais il servirait n. servirions v. serviriez ils serviraient	sers qu'il serve servons servez q. i. servent	je serve tu serves il serve n. servions v. serviez ils servent	je servisse tu servisses il servît n. servissions v. servissiez ils servissent
Sortir, 2, *to go out*	sortant sorti, *f.* -e	je sors see Sentir	je sortais	je sortis	je sortirai	je sortirais	sors	je sorte	je sortisse
Souffrir, 2, *to suffer*	souffrant souffert, *f.* -e	je souffre see Ouvrir	je souffrais	je souffris	je souffrirai	je souffrirais	souffre	je souffre	je souffrisse
Soumettre, 1, *to submit*	soumettant soumis, *f.* -e	je soumets see Mettre	je soumettais	je soumis	je soumettrai	je soumettrais	soumets	je soumette	je soumisse

J. — B. Bossuet, who in some respects may be regarded as the typical prose-writer of the reign of Louis XIV., was born in 1627 at Dijon. He was brought up for the Church from his boyhood, and after being instructor of the Dauphin was, in 1681, made Bishop of Meaux. He wrote four articles concerning the liberties of the Gallican Church, and in 1697 he was appointed a Privy Councillor. His death took place at Meaux in 1704. He was a controversialist of extraordinary power, and offered an energetic opposition to the Protestants. Fénelon was one of his most determined adversaries. The best known of his works are "L'Histoire des Variations des Églises Protestants" and "Discours sur l'Histoire Universelle jusqu'à l'Empire de Charlemagne." There is a grandeur in his style, a depth and earnestness in his views, which have always won readers for his works.

Éloquence de Saint Paul.

N'attendez pas de l'Apôtre ni qu'il vienne flatter les oreilles par des cadences harmonieuses, ni qu'il veuille charmer les esprits par de vaines curiosités. Saint Paul rejette tous les artifices de la rhétorique. Son discours, bien loin de couler avec cette douceur agréable, avec cette égalité tempérée que nous admirons dans les orateurs, paraît inégal ou sans suite à ceux qui ne l'ont pas assez pénétré; et les délicats de la terre, qui ont, disent-ils, les oreilles fines, sont offensés de la dureté de son style irrégulier. Pourtant, mes frères, n'en rougissons pas. Le discours de l'Apôtre est simple, mais ses pensées sont toutes divines. S'il ignore la rhétorique, s'il méprise la philosophie, Jésus-Christ lui tient lieu de tout; et son nom qu'il a toujours à la bouche, ses mystères qu'il traite si divinement, rendront sa simplicité toute-puissante. Il ira, cet ignorant dans l'art de bien dire, avec cette locution rude, avec cette phrase qui sent l'étranger, il ira en cette Grèce polie, la mère des philosophes et des orateurs, et, malgré la résistance du monde, il y établira plus d'églises que Platon n'y a gagné de disciples par cette éloquence qu'on a crue divine. Il prêchera Jésus dans Athènes, et le plus savant de ses sénateurs passera de l'Aréopage en l'école de ce barbare. Il poussera encore plus loin ses conquêtes; il abattra aux pieds du Sauveur la majesté des faisceaux romains en la personne du proconsul, et il fera trembler dans leurs tribunaux les juges devant lesquels on le cite.

Rome même entendra sa voix; et un jour cette ville maîtresse se tiendra bien plus honorée d'une lettre du style de Paul adressée à ses concitoyens, que de tant de fameuses harangues qu'elle a entendues de son Cicéron.

PNEUMATICS.—V.

[Continued from p. 44.]

PRACTICAL APPLICATIONS.

THE SIPHON.

The *Siphon* simply consists of a bent tube with two legs, usually of unequal length. It is used to draw off liquid from one vessel, in which one end of the tube is immersed, after the tube has been carefully filled with the liquid. This then passes up over the bend of the tube, and is ultimately discharged from the other end of the tube either into the air or into another vessel at a lower free surface-level than the first. Although the liquid does flow uphill to get over the bend of the siphon tube, this only occurs whilst it is flowing from a higher to a lower free surface-level. *The action of this instrument depends on atmospheric pressure and the weight of the liquid.*

First of all, the siphon tube A B is turned with the ends of the tube upwards, and when filled with liquid, both ends of the tube are closed to prevent escape of liquid or inflow of air whilst the tube is inverted and one end immersed in the vessel, as shown in Fig. 12.

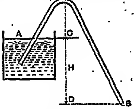


Fig. 12

A C is the level of the free surface of liquid in the vessel; whilst D B is the level of the other end of the leg of the siphon, where the liquid is discharged. Then C D is the difference of level between the free surface of the liquid in the vessel A to be emptied and the outflow end of the siphon at B.

Let H be the height of a column of the liquid which supports, or is equivalent to, the atmospheric pressure. In the case of water, H is a little over 33 feet, that is, the height of a barometric column of water.

Now, it is easy to see that the siphon will cease to act when the highest point of the bend P is more than H feet above the upper free surface of the liquid, because the atmospheric pressure on the free surface A cannot urge the liquid up the tube to a greater height than H; consequently a Torricellian vacuum is formed in the upper part of the inverted loop. In the case of mercury, this height H must not exceed 30 inches; and for every liquid the highest point of the bend P must not be more than the height of the barometer column of that particular liquid above the free surface.

The action of the siphon may be understood by

considering the pressure on each side of a thin vertical slice of the liquid at the highest point P of the tube. We will express the pressures in terms of the height of columns of the liquid in the siphon.

Since the pressure at A on the free surface of the liquid is simply H, that of the atmosphere, the pressure at the height CP, on the slice at P, on the side next A, the higher free surface, is

$$H - CP.$$

When the whole of the siphon tube is full of liquid, the pressure at P, on the other side next B, is

$$H - PD.$$

This pressure is less than the former by that of the column CD, or h, since

$$PD - PC = CD.$$

Hence the resultant force at P, due to the depth h of the liquid column, tends to cause the liquid to flow towards B.

The direction of flow, therefore, depends on the difference between the levels of the two free surfaces of the liquid.

Now, there is this tendency of the liquid in the siphon tube to flow towards B. Fig. 12, and as soon as this end is opened, the weight of the liquid will cause it to escape from B, relieving the pressure on this side, so that the resultant force will then maintain a continuous stream from the vessel A until the liquid is all drawn off or the free surface-level of the liquid in A falls below B.

When there is a sufficient fall or difference of level H, the only difficulty is in starting the siphon to work. It is necessary to have the siphon tube completely filled with the liquid to be removed, and then close the ends to prevent air entering or liquid escaping while the one leg A is being immersed in the liquid and the other B kept closed and placed at a *lower* level, as shown in Fig. 12. The flow is *then* started by simply opening the end B to allow the liquid to escape.

A tall chimney may be considered as one leg of an inverted siphon, in which there is an upward flow of the *light* heated air displaced by the heavier column of cool air outside.

MANOMETERS OR PRESSURE-GAUGES.

Manometers or pressure-gauges are instruments for measuring the pressure or elastic force of a gaseous fluid in any closed space.

The Siphon-gauge, Fig. 13, is used to measure small pressure. It consists of a U-shaped tube of glass, open to the atmosphere at end A, and having a brass elbow or other arrangement at B to fix on the vessel and open communication with the space containing the gaseous fluid. Water or mercury is poured into the bend of the tube, and sometimes the arm P D is widened into a bulb to contain sufficient liquid for the range of pressure it is desired to measure without requiring a long tube.

The action of this instrument is obvious to our readers. When the pressure at B is the same as that of the atmosphere at A, the liquid will stand at the same level C in both arms of the tube. When the pressure at B is less than atmospheric, the liquid column will be forced down, say to D, in the right-hand branch, and will rise an equal amount C P in the left-hand branch; then the pressure of the gas at B is less than atmospheric by that due to the column of liquid of height D P, the difference of level between the ends of the liquid column. On the other hand, when the pressure at B is greater than that of the atmosphere, the liquid will rise in the branch A, and the difference in pressure is given by the difference of level between the tops of the liquid in the two branches.

COMPRESSED AIR MANOMETER.

When pressures much greater, as well as less, than one atmosphere have to be measured, air may be enclosed in the end A, Fig. 13, above mercury. This pressure-gauge consists of a bent glass tube, with one branch A closed, containing air above a column of mercury, which occupies the bend and part of the other branch. The branch P B is fitted with a brass elbow and stop-cock, so that it can be fixed or screwed into the vessel containing the gaseous fluid whose pressure is to be measured.

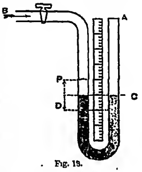


Fig. 13.

When the mercury stands at the same height in both branches of the tube, the pressure of the gas will be the same as the atmospheric pressure. If the mercury rises, say to P, in the left branch, then the pressure of the gas in communication with B is less than atmospheric, and is read off the scale corresponding to the top of the mercury in the right-hand branch.

As the pressure at B increases above atmospheric, the mercury is forced up into the right-hand branch A, and compresses the air in that end of the tube. The total pressure exerted by the gas at B is then partly indicated by the volume of the compressed

air, *together with* the pressure due to the column of mercury equal to the difference of level of the mercury in the two branches, which is evidently supported by the pressure at B. This total pressure is usually given on the scale next the branch A. Instead of calculating the pressure by the volume occupied by the compressed air, and then adding on the pressure due to the difference of level of the mercury, the graduations on the scale are ascertained once for all by comparing the indications of the instrument throughout its range with the total pressures as given by a mercurial column or standard monometer. This process, called the *calibration* of the instrument, consists in comparing all the readings throughout the scale of this measuring instrument with the indications of a standard instrument, or with absolute values of the pressure as given by the height of a mercurial column.

VACUUM GAUGES.

Various kinds of gauges have been devised to measure the pressure in a vacuum, or, in other words, small pressures far below that of the atmosphere. At first sight, the simplest and most direct method of measuring such low pressures would appear to be by comparing them with the pressure in a Torricellian vacuum. Thus, the vacuum pressure in the condenser of a steam-engine, for instance, may be measured by the arrangement shown in Fig. 14. The height of the barometric column of mercury in the right-hand tube A varies with the pressure of the atmosphere; indeed, A is simply a good barometer fitted with vernier and scales at the top in the usual way, although to simplify matters these graduations are not shown in Fig. 14.

Fig. 14.

The left-hand tube is exactly similar, except that there is a bend at the top B, with a stopcock to open communication with the space containing the residual gas whose pressure is to be measured. These two tubes, of the same bore to avoid errors due to capillarity, are mounted quite close to each other, so that the atmospheric pressure on the pools of mercury at their base must be the same for both. Hence when the mercury columns stand at the same height in both tubes, there will be the same pressure on the tops of these columns. In the barometer tube there is the ordinary pressure of mercury vapour in the Torricellian vacuum above the mercury, which for many practical purposes may be taken to represent *zero* pressure. By adjusting the zero of the scale between the two tubes to the point at which the barometric column A stands at any time, then the reading on the scale opposite the top of the column P gives the pressure in B above this zero pressure of the Torricellian vacuum. If the mercury in the tube P falls to the free surface-level of the mercury in the vessel at the bottom of the tube, then the pressure at B will simply be equal to that of the atmosphere at the time, and this pressure may be at once read off by the height of the barometer column A standing alongside and, therefore, exposed to the same atmospheric variations and disturbances. If the mercury in the tube P fluctuates, owing to variations in the pressure being measured, the highest and lowest points should be noted. Usually the scale on this mercurial gauge P gives the pressure in pounds per square inch directly.

When the mercurial columns in such a barometer gauge and in the barometer itself are level, the vacuum pressure is equal to that in the Torricellian vacuum, which used to be called a perfect vacuum. However, various experiments can detect the pressure of the residual air, and show that this vacuum is very imperfect indeed. Moreover, the pressure in such vacua can be measured by means of the

MACLEOD GAUGE.

A simple form of the MacLeod gauge is seen in Fig. 15. It works upon the principle of compressing a known volume of the rarefied air or gas into a very much smaller volume; so that the ratio of the two volumes is exactly and accurately known when the pressure becomes appreciable and can be measured in the reduced volume, whence the very small pressure at the original volume may be readily calculated by Boyle's law.

Let V be the volume of the bulb-full of rarefied gas, which is compressed into the small volume v in the

Fig. 15.

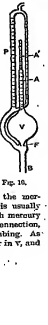


Fig. 10.

narrow graduated tube A, by raising the mercury in the barometric tube B. This is usually done by simply raising a vessel filled with mercury and attached to the tube B by a flexible connection, such as a stout piece of india-rubber tubing. As the mercury is raised, it encloses the air in V, and

then compresses it into A, rising at the same time in the pressure tube P, which remains in communication with the rarefied air.

The gauge tubes A and P are made of exactly the same bore, to eliminate errors due to capillarity. If the large known volume V of rarefied gas, under the small unknown pressure p, be compressed until it occupies a smaller volume v, then the pressure upon the gas is partly due to the observed mercurial pressure, measured as the difference of levels, h, of the mercury in the two tubes A and P, as well as to the residual gas pressure p in the top of the tube P above the mercury.

Hence, according to Boyle's law, we have

$$pV = (p + h)v,$$

therefore it follows that

$$p(V - v) = hv,$$

and

$$p = \frac{hv}{V - v}.$$

If h is measured in millimetres of mercury on the tube P, graduated in millimetres, then the pressure p will be obtained in the same units. In order to express this pressure in fractions of an atmosphere, we have only to divide the numerical value of p in millimetres by 760, since the standard atmospheric pressure is taken as equal to that of a column of mercury 760 millimetres high at 0° Cent. It is necessary to ensure that an exact amount of the residual air in V is enclosed therein by the rising mercury, and not swept out of V and up the tube P before the incoming mercury. On this account, Gimingham has modified McLeod's gauge, as shown in Fig. 16, by providing below the bulb V a narrow funnel-shaped aperture F, having a perfectly level end or mouth, so that as the mercury column in B is raised it encloses a perfectly definite and known volume of air in the bulb V.

Moreover, when the residual air in V is compressed into an exceedingly small volume in A, the range of reading on the graduated tube P of the same bore becomes very small and limited. In order to overcome this difficulty, Gimingham makes the volume tube A consist of two parts of different bore, the upper end A′, Fig. 16, consisting of very narrow tubing for measuring the smallest remaining traces of air or gas.

For this purpose there are two pressure tubes P and P′ of exactly the same size glass tubing as the two parts of the volume tube A and A′, into both of which the mercury rises at the same time. The wide tube P gives the larger readings of pressure, whilst the very narrow part P′ must have its graduations very far apart over a wide range for an excessively small change of pressure, so that the pressure of the smallest trace of air when compressed in volume tube A′ can be measured in the pressure tube P′.

Another difficulty consists in the tendency of the air to adhere to the glass and get flattened between the mercury and glass, forming a thin condensed gaseous film which cannot be easily removed. On this account, when great accuracy is required, the *apparatus must be heated* to as high a temperature as safety will allow for some time before attempting to measure the pressure of the residual gas in the vacuum. The heating has the effect of driving or squeezing out the film of air, so that the mercury gets more intimately into contact with the glass, and appears to have a much brighter surface as seen through the glass. Besides, the pressure of the small trace of residual air will increase with the temperature, thus becoming appreciable and more accurately measured.

MERCURIAL AIR-PUMPS.*

Geissler Pump.

Mercurial air-pumps are designed to render as perfect as possible the Torricellian vacuum in a tube or enclosed space above a barometric column. The earliest mercurial air-pumps *forced the air upwards above the top of the barometric column.* In the year 1855 Dr. H. Geissler, of Bonn, invented the famous air-pump which he used in exhausting the well-known Geissler vacuum tubes, giving a beautiful display of colour by the electric spark, depending chiefly on the degree of exhaustion of the tubes.

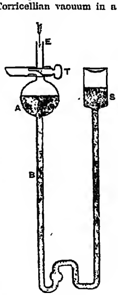


Fig. 17.

The first form of this pump is shown in Fig. 17. It consists of a barometric tube B connected at the lower end, by means of a flexible indiarubber tube, with a vessel S containing a supply of mercury. The top of the barometric tube opens into a large glass bulb or globe A, called the *pump-head*, which is provided with a three-way tap T—when turned into one position, this tap T opens communication between

* See paper on "The Development of the Mercurial Air-Pump," by Professor Silvanus P. Thompson, D.Sc., B.A., in the *Journal of the Society of Arts*, November 25th, 1887

A and the outer air, and in another position the outer opening is closed, and A is in communication with the exhaust tube E.

The action of this simple arrangement is as follows:—When the tap T is turned to open A to the outer air, the supply cistern S is raised, and the mercury fills the pump-head A and drives out all the air in it through the tap T to the outer air. The tap T is then turned to shut off the outer air and to open communication between the pump-head A and the vessel to be exhausted by the pipe E. Then the supply vessel S is lowered, and the mercury A gradually falls in the pump-head, sucking in after it, through the exhaust pipe E, the air from the vessel being exhausted. The tap is now turned to again open communication with the outer air, and the supply vessel S is raised to expel the air from A.

These operations are repeated many times, until as much as possible of the air is exhausted by the pipe E from the vessel or space to which it is attached.

Communication is opened alternately between the pump-head and (1) the exhaust pipe E, while the supply vessel S is lowered to draw the air down into A; and (2) between the pump-head A and the outer air to expel completely all the air from A by raising the supply vessel S. The perfection of the vacuum that can be obtained is limited in the first place by leakage through the three-way tap. To remedy this defect, we find in recent forms a series of three taps above the pump-head, instead of one—the upper two are to enable the last traces of air to be expelled from the pump-head. Several other improvements have been introduced, and special precautions taken to prevent fracture of the glass top, as experience in everyday work revealed various imperfections.

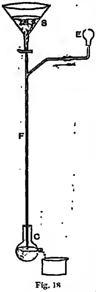


Fig. 18

Sprengel Pump.

The next important idea in mercurial air-pumps is to remove the residual air from the top of the barometric column, or from any closed vessel attached thereto, by *driving the air down the barometric tube.*

In the year 1865 Dr. Hermann Sprengel brought out an air-pump of this type. The first simple form is shown in Fig. 18. The supply vessel S was a funnel fixed above the barometer tube F, and attached to the latter by an indiarubber tube nipped by an adjustable pinch-cock to regulate the rate at which mercury is allowed to drop down the glass tube F. This glass tube, called the *fall-tube*, F, is about 39 inches long, and has a narrow internal bore of about 1·5 or 2 millimetres, depending upon the rapidity of working and degree of exhaustion required. As the drops of mercury fall down this tube, they act as little cylinders, driving down the air cylinders below them. These cushions of air break the fall of the mercury, and become more compressed as they descend. When nearly all the air is swept out, the mercury drops fall more quickly through the vacuous space in the tube, taking all the residual air from the exhaust tube E, and falling with a loud, sharp, metallic clink on the top of the barometric column. In fact, the fall tubes are liable to crack and break off at this point, about 30 inches above the lower end, hence these fall tubes require to be made strong. The mercury falls into the cup C, and is collected in another vessel, from which it can be poured again into the supply funnel S at the top. However, in this operation air is likely to be introduced with the mercury into the top of the fall tube.

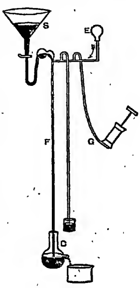


Fig. 19.

In the second form of Sprengel pump, Fig. 19, a U-shaped bend is inserted between the supply funnel and a small chamber corresponding to the pump-head, from which the mercury drops into the fall tube F. A small mechanical air-pump is used to commence the exhaustion, or rough out the air, and the exhaustion is finished by opening the pinch-cock, allowing the mercury to drop down the fall tube, whilst the barometric gauge G showed the degree of rarefaction.

Many mechanical details and improvements have been found necessary in practice. The mercury is usually introduced into the pump-head by a jet tube with narrow orifice, spurts into a fine stream,

and passes down three, five, or even seven fall tubes placed alongside of one another. Air traps are also used to prevent air passing in with the mercury supply.

Glacial acetic acid removes the film of oxide from the mercury, and keeps the Sprengel pump clean. It is also necessary to use drying substances, such as concentrated sulphuric acid and glacial phosphoric acid. Gold leaf is used to absorb the mercury vapour.

Toepler Pump.

The most important type of mercurial air-pump consists of a combination of the Geissler and Sprengel pumps, since in this type of pump the *air is driven up at the top of one barometric column and is then expelled from the pump-head down another barometric column.* The essential parts of the Toepler pump will be seen in Fig. 20. As the supply vessel S is lifted, the mercury flowing through the flexible rubber-tube rises in the barometric tube B and in the pump-head A. First, the mercury cuts off communication with the vessel E to be exhausted, by entering the exhaust tube H, and soon drives the air enclosed in A up before it, and finally down the narrow barometric tube F, when the air escapes by the mercury cup, which acts as a trap at the bottom of this barometric tube. The tube H must stand more than 30 inches above the pump-head to prevent mercury being driven over the bend into the vessel E to be exhausted. This tall tube H has been shortened in recent modern forms, as the Swinburne pump, by an automatic valve on the exit tube above the pump-head A; whilst the eject tube or fall tube is furnished with a large eject chamber; whilst a siphon bend or mercury trap, and a little chamber between the pump-head and the automatic valve makes the pump capable of producing a very good vacuum, though it appears hopeless to get a really perfect vacuum by any available means as yet known.

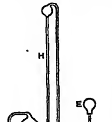


Fig. 20.

The common air-pump, consisting of cylinders, pistons, and exhaust pipe, with suitable valves, by which air is withdrawn from an enclosed space by purely mechanical means, cannot produce anything like so high a degree of exhaustion or rarefaction as any of the mercurial pumps above described.

The applications of the mechanical air-pump and of compressed air are wide and varied, and of great importance to the engineer and to the scientific student.

ELOCUTION.—I.

PUNCTUATION.

THE invention of the modern system of punctuation has been attributed to the Alexandrian grammarian Aristophanes, after whom it was improved by succeeding grammarians; but it was so entirely lost in the time of Charlemagne, that he found it necessary to have it restored by Warnefried and Alcuin. It consisted at first of only one point, used in three ways, and sometimes of a stroke, formed in several ways. But as no particular rules were followed in the use of these signs, punctuation was exceedingly uncertain until the end of the fifteenth century, when the learned Venetian printers, the Manutii, increased the number of the signs, and established some fixed rules for their application. These were so generally adopted, that we may consider the Manutii as the inventors of the present method of punctuation: and although modern grammarians have introduced some improvements, nothing but a few particular rules have been added since their time.

The design of the system referred to was purely grammatical, and had no further reference to enunciation than to remove ambiguity in the meaning and to give precision to the sentence. This, therefore, is the object of punctuation, and although the marks employed in written language may sometimes denote the different pauses and tones of voice which the sense and accurate pronunciation require, yet they are more generally designed to mark the grammatical divisions of a sentence, and to show the dependence and relation of words and members which are separated by the intervening clauses. The teacher, therefore, who directs his pupils to "*mind their pauses in reading*," gives but an unintelligible direction to those who are unversed in the rules of analysis. A better direction would be to disregard the pauses, and endeavour to read the sentence with just such pauses and tones as they would employ if the sentence were their own, and they were uttering it in common conversation. Indeed, it is often the case that correct and tasteful reading requires pauses, and these too of a considerable length, to be made, where such pauses are

indicated in written language * by no mark whatever. It is not unfrequently the case that the sense will allow no pause whatever to be made in cases where, if the marks alone were observed, it would seem that a pause of considerable length is required. The pupil, therefore, who has been told to *mind his pauses*, must first be taught to *unlearn* this direction, and endeavour to *understand* the sentence which he is to read, before he attempts to enunciate it.

The characters employed in written language are the following:—

The Comma,	,	The Breve,	
The Semicolon,	;	The Apostrophe,	' ['tis]
The Colon,	:		
The Period,	.	The Brace,	}
The Dash,	—		
The Exclamation	!	The Acute Accent,	´
The Interrogation,	?	The Grave Accent,	`
The Quotation Marks	" "	The Circumflex Accent,	⁀
The Diæresis,	¨	or	^
The Crotchets,	( )	The Caret,	^
The Brackets,	[ ]	The Cedilla,	ç
The Obelisk or Dagger,	†	The Asterisk,	*
The Double Obelisk or Double Dagger,	‡	The Section,	§
The Hyphen	-	The Paragraph,	¶
		The Parallels,	‖

The Ellipsis, sometimes expressed by Periods, thus, ...
" sometimes by Hyphens, thus, - - - - -
" sometimes by Asterisks or Stars, thus, * * * *
" sometimes by a Dash prolonged, thus, ————

These characters, when judiciously employed, *fix* the meaning and give precision to the signification of sentences, which, in a written form, would be ambiguous or indefinite without them. Thus, "I said that he is dishonest it is true and I am sorry for it." Now the meaning of this sentence can be ascertained only by a correct punctuation. If it be punctuated as follows: "I said that he is dishonest, it is true, and I am sorry for it," the meaning will be, that it is true that I said he is dishonest, and I am sorry that I said so. But if it be punctuated thus, "I said that he is dishonest; it is true; and I am sorry for it," the meaning will be, "I said that he is dishonest; it is true that he is dishonest, and I am sorry that he is so."

A further instance of the importance of correct punctuation was afforded by an advertisement in which the commissioner for lighting one of the largest commercial cities of Europe, by the misplacing of a comma in his advertisement, would have contracted for the supply of but half the required light. The advertisement represented the lamps as "4,050 in number, having two spouts each, composed of not less than twenty threads of cotton." This expression implied that the lamps had each two spouts, and that the two spouts had twenty threads—that is, each spout had ten threads. But the meaning that the commissioner intended to convey was, that each spout had twenty threads: and his advertisement should have had the comma after "spouts," instead of after "each."

These instances might suffice to illustrate the nature and the propriety of correct punctuation; but the following instance, known to many, will show the importance of the subject. The clerk of a congregation in Scotland had a paper handed to him, as the custom is, to read just before the minister stood up to pray *with* and *for* the congregation, containing the following words, unpointed: "A man going to sea his wife desires the prayers of the congregation." The clerk read it as if a comma had been put at the end of the word *wife*, and unfortunately excited, in no small degree, the risible faculties of the people assembled:—thus, "A man going to sea (*see*) his wife, desires the prayers of the congregation."

But although the meaning of a sentence is thus materially affected by the punctuation, it will be seen in the following lessons that the punctuation alone is an unsafe guide to follow in the enunciation of any collection of words. For, in many cases, these marks indicate no pause, emphasis, or other circumstance requiring notice in the enunciation of the sentence.

The nature of the marks used in written language may also be understood by a reference to the origin of their names.

The word *Comma* is derived from the Greek language, and properly designates a section, or part *struck off* from a complete sentence. In its usual acceptation, it signifies the point which marks the smaller portions of a period. It therefore represents the shortest pause, and consequently marks the least constructive, or most dependent parts of a sentence.

The word *Colon* is from the Greek, and signifies a *member* of a sentence, and the Latin prefix *semi* means *half*. Hence, a *Semicolon* is used for the purpose of pointing out those parts of a compound sentence which, although they each constitute a distinct proposition, have yet a dependence upon each other, or on some common clause. The *Colon* is used to divide a sentence into two or more parts, which, although the sense be complete in each, are not independent. The *Colon* is also used in chanting, to indicate the division of a verse.

The word *Period* is derived from the Greek, and means a *circuit* or well-rounded sentence. Hence, when the circuit of the sense is completed, with all its relations, the mark bearing this name is used to denote this completion.

* The term "written language" of course includes *printed* language.

The *Dash* is only once used in the Bible, where it is employed as an ellipsis (Exod. xxxii. 32).

The word *Interrogation* is derived from the Latin, and means *a question*. Hence this mark is put at the end of a question.

The word *Exclamation* is from the same language, and means *a passionate utterance*. Hence the mark so called is put at the end of such utterances.

The word *Parenthesis*, derived from the Greek language, means *an insertion*. A sentence, clause, or phrase, inserted between the parts of another sentence for the purpose of explanation, or of calling particular attention, is properly called a parenthesis.

It is to be remarked, however, that the name parenthesis belongs only to the *sentence inserted* between *brackets* or *crotchets*, and not to those marks themselves.

The word *Hyphen* is derived from the Greek language, and signifies *under one*, that is, *together*; and is used to imply that the letters or syllables between which it is placed are to be taken *together* as one word.

The hyphen, when placed over a vowel, to indicate the long sound of the vowel, is called *the Macron*, from the Greek, signifying *long*.

The mark called *a Breve*, indicating the short sound of the vowel, is from the Latin, signifying *short*.

The word *Ellipsis*, also from the Greek, means an *omission*, and properly refers to the words, members, or sentences which are omitted, and not to the marks which indicate the omission.

The word *Apostrophe*, also from the Greek, signifies the *turning away*, or the omission of one letter or more. The word apostrophe, as here used, must not be confounded with the same word as the name of a rhetorical figure.

The word *Diæresis* is also from the Greek, and signifies *the taking apart*, or the separation of the vowels, which would otherwise be pronounced as one syllable.

The term *Accent* is derived from the Latin language, and implies *the tone of the voice* with which a word or syllable is to be pronounced.

The word *Section*, derived also from the Latin, signifies a *cutting*, or a *division*. The character which denotes a section seems to be composed of *ss*, and to be an abbreviation of the words *signum sectionis*, or the sign of a section. This character, which was formerly used as the sign of the division of a discourse, is not often used, except as a reference to a note at the bottom of the page.

The word *Paragraph* is derived from the Greek language, and signifies *a writing in the margin*. This mark, which, like the section, was formerly used to designate those divisions of a section which are now indicated by unfinished lines or blank spaces, is employed in the English version of the Old and New Testaments to mark the commencement of a fresh subject.

It may further be remarked, that notes at the bottom of the page, in the margin, or at the end of a book, are often indicated by figures or by letters, instead of the marks which have already been enumerated.

The word *Caret* is from the Latin, and signifies *it is wanting*. This mark is used only in manuscripts.

The *Cedilla* is a mark placed under the letters *c* and *g* to indicate the soft sound of those letters.

The *Asterisk*, *Obelisk*, *Double Obelisk*, and *Parallels*, with the section and paragraph, are merely arbitrary marks to call attention to the notes at the bottom of the page.

As these marks which have now been enumerated all have a meaning, and are employed for some special purpose, it is recommended to the student never to pass by them without being assured that he understands what that purpose is. Correct and tasteful reading can never be attained without a full appreciation of the meaning which the author intended to convey; and that meaning is often to be ascertained by the arbitrary marks employed by him for the purpose of giving definiteness to an expression. At the same time, the student should consider these marks as his guide to the *meaning* only, not to the enunciation of a sentence. Correct delivery must be left to the guidance of taste and judgment otherwise acquired.

I. THE PERIOD.

1. *The Period is a round dot or mark which is always put at the end of a sentence.*

2. In reading, when you come to a period, you must stop as if you had nothing more to read.

3. You must stop only as long as you can count *one, two, three, four*.

4. You must pronounce the word which is immediately before a period with the *falling inflection* of the voice.

5. The *falling inflection* (or *bending*) of the voice is commonly marked by the *grave accent*, thus, \`.

Examples

Charles has bought a new hat.
I have lost my gloves.
Exercise and temperance strengthen the constitution.
A wise son makes a glad father.
The fear of the Lord is the beginning of wisdom.

II. THE NOTE OF INTERROGATION.

?

6. *The note or mark of Interrogation is a round dot with a hook above it, which is always put at the end of a question.*

7. In reading, when you come to a note of interrogation, you must stop as if you waited for an answer.

8. You must stop only as long as you do at the *period*.

9. You must in most cases pronounce the word which is placed immediately before a note of interrogation with the *rising inflection* of the voice.

10. The *rising inflection* of the voice is commonly marked by the *acute accent*, thus, ′.

Examples.

Has Charles bought a new hát?
Have you lost your glóves?
Hast thou an arm like Gód?
Canst thou thunder with a voice like hím?
If his son ask bread, will he give him a stóne?
If he ask a fish, will he give him a sérpent?

11. In general, read declaratory sentences or statements with the *falling* inflection, and interrogative sentences or questions with the *rising* inflection of the voice.

Examples.

Interrogative.	Has John arrived?
Declaratory.	John has arrived.
Interrogative.	Is your father well?
Declaratory.	My father is wèll.
Interrogative.	Hast thou appealed unto Cæsar?
Declaratory.	Unto Cæsar shalt thou gò.

12. Sometimes the sentence which ends with a note of interrogation should be read with the *falling* inflection of the voice.

Examples.

What o'clock is it?
How do you do to-dày?
How much did he give for his bòok?
Where is Abel thy bròther?
How long, ye simple ones, will ye love simplicity?
Where wast thou, when I laid the foundations of the èarth?

13. Sometimes the first part of an interrogative sentence should be read with the *rising* inflection of the voice, and the last part with the *falling* inflection. These parts are generally separated by a *Comma*, thus, ,

14. At the comma, the *rising* inflection is used, and at the note of interrogation the *falling* inflection.

Examples.

Shall I give you a péach, or an àpple?
Are you going hóme, or to schòol?
Last Sabbath, did you go to chúrch, or did you stay at hòme?
Whether is it easier to say, Thy sins are forgiven, or to say, Arise and wàlk?
Why did the heathen ráge, and the people imagine vain things?
Is your father wéll, the old man of whom ye spàke?

15. Sometimes the first part of an interrogative sentence must be read with the *falling* inflection of the voice, and the last part with the *rising* inflection.

Examples.

Where have you been to-dày? At hóme?
Who told you to retùrn? Your fáther?
What is that on the top of the hòuse? A bírd?
What did you pay for that bòok? Three shíllings?
Is not the life more than mèat? and the body than ráiment?
What went ye out to sèe? A man clothed in soft ráiment?
What went ye out to sèe? A próphet?
How often shall my brother sin against me and I forgive him? Until seven times?

16. In the following exercises some of the sentences are questions requiring the *rising*, and some the *falling* inflection of the voice. A few sentences also ending with a period are inserted. No directions are given to the pupil with regard to the manner of reading them, it being desirable that his own understanding, under the guidance of nature alone, should direct him. But it may be observed that questions which can be answered by *yes* or *no*, generally require the *rising* inflection of the voice; and that questions which cannot be answered by *yes* or *no*, generally require the *falling* inflection.

EXERCISE 1.

John, where have you been this morning?
Have you seen my father to-day?
What excuse have you for coming late this morning? Did you not know that it is past the school hour?
If you are so inattentive to your lessons, do you think that you will make much improvement?
Will you go, or stay? Will you ride, or walk?
Shall you go to-day, or to-morrow?
Did he resemble his father, or his mother?
Is this book yours, or mine? His, or hers?
Do you hold the watch to-night? We do, sir.
Did you say that he was armed? He was armed.
Did you not speak to him? I did.
Art thou he that should come, or do we look for another?
Why are you so silent? Have you nothing to say?
Who hath believed our report? To whom hath the arm of the Lord been revealed?

III. THE NOTE OF EXCLAMATION.

!

17. *The note or mark of Exclamation is a round dot with an upright dash or stroke above it, which is always put at the end of a sentence expressing surprise, astonishment, wonder, or admiration, or other strong feelings.*

18. In reading, when you come to a note of exclamation, you must stop in the same manner as if it were a note of interrogation.

19. You must stop only as long as you do at a period.

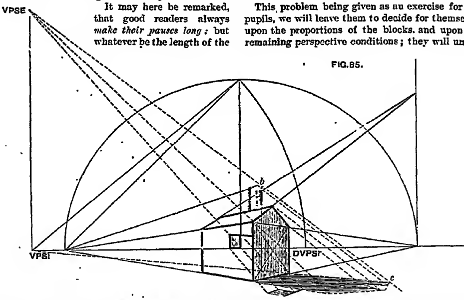
20. You must generally pronounce the word which comes immediately before a note of exclamation with the *falling* inflection of the voice.

Examples.

How cold it is to-day!
What a beautiful house that is!
How brightly the sun shines!
How mysterious are the ways of Gòd!
How are the mighty fallen in the midst of the bàttle!
How are the mighty fallen, and the weapons of wàr pérished!
Would God I had died for thee, O Absalom, my son, my sòn!
Oh, what a fall was there, my countrymèn!
It is a dread and awful thing to die!
Oh! deep enchanting prelude to repòse!
The dawn of bliss the twilight of our wòes!
Lovely art thou, O Pèace! and lovely are thy children; and lovely are thy footsteps in the green vàlleys!

21. In our remarks on the period, the student was taught that when he comes to a period, he must stop, as if he had nothing more to read. At the end of a paragraph, whether the period or any other mark be used, a longer pause should be made than at the end of an ordinary sentence. The notes of interrogation and exclamation generally require pauses of the same length with the period.

It may here be remarked, that good readers always *make their pauses long*: but whatever be the length of the



pause, the pupil must be careful that every pause which he makes shall be a *total cessation of the voice.*

EXERCISE 2.

The sentences to be read as if marked.

A good scholar is known by his obedience to the rules of the school. He obeys the directions of his teacher. His attendance at the proper time of school is always punctual. He is remarkable for his diligence and attention. He reads no other book than that which he is desired to read by his master. He studies no lessons but those which are appointed for the day. He takes no toys from his pocket to amuse himself or others. He pays no regard to those who attempt to divert his attention from his book.

Do you know who is a good scholar? Can you point out many in this room? How negligent some of our fellow-pupils are! Ah! I am afraid many will regret that they have not improved their time!

Why, here comes Charles! Did you think that he would return so soon? I suspect that he has not been pleased with his visit. Have you, Charles? And were your friends glad to see you? When is cousin Jane to be married? Will she make us a visit before she is married? Or will she wait until she has changed her name?

GEOMETRICAL PERSPECTIVE.—X.

[Continued from p. 51.]

PROBLEMS—LII.—LV.

PROBLEM LII. (Fig. 84).—*A Slab and a Block. The slab is placed on its edge at an angle of 30° with the PP. The block is in an upright position, and parallel with the slab at some distance beyond it; sun's elevation 50°, and inclination 40°.*

This problem being given as an exercise for our pupils, we will leave them to decide for themselves upon the proportions of the blocks, and upon the remaining perspective conditions; they will understand that the process for casting the shadow will be the same as shown by Fig. 83. At the same time we must draw attention to some parts of the shadows where the construction may not be clearly understood. The ray of the sun's inclination, through *a* of the block, meets the one through *b* from the sun's elevation, making the extent of the

shadow of $a\,b$ to be $a\,c$. The other corresponding ray of elevation through d, meeting the ray of inclination at c, determines the shadow of $b\,d$ to be $c\,c$, which has the same vanishing point as $b\,d$, viz., VP¹. The shadow of the perpendicular edge $m\,n$ is $m\,o$; join $e\,o$, which will be the shadow of $d\,n$; then upon the same principle as in the case of the shadow of $b\,d$ will the shadow of $d\,n$, viz., $e\,o$, vanish at VP². To determine the edge of the shadow as it crosses the slab, draw a perpendicular line from the point in which the shadow line $a\,c$ cuts the base line of the slab, either from h or i, to meet the upper edge of the slab in s or v; if preferred, both lines may be drawn, then by joining s and v the edge of the shadow of the block crossing the slab will be determined; if one of the lines only is drawn, then the edge of the shadow represented by $s\,v$ must be directed towards VPSI.

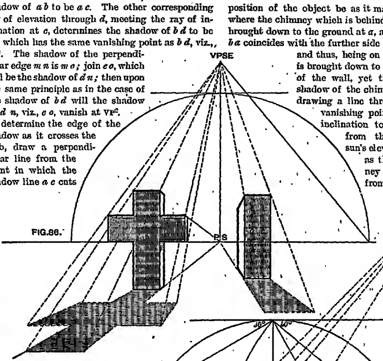


FIG. 86.

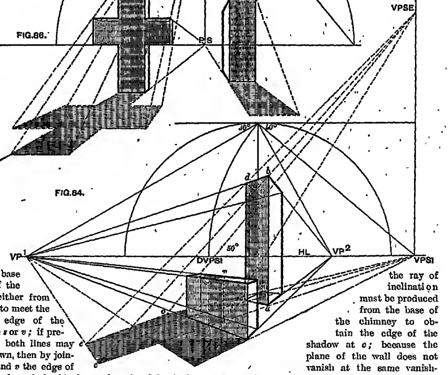


FIG. 84.

The rays of the sun's inclination and those of the elevation must always be drawn in order to obtain the determination or extent of the shadow, let the position of the object be as it may, as in Fig. 85, where the chimney which is behind the building is brought down to the ground at a, although the line $b\,a$ coincides with the further side of the building, and thus, being on the same plane, is brought down to the ground line of the wall, yet the edge of the shadow of the chimney is found by drawing a line through a from the vanishing point of the sun's inclination to meet the ray from the one of the sun's elevation; the same as though the chimney had projected from the wall, when the ray of inclination must be produced from the base of the chimney to obtain the edge of the shadow at c; because the plane of the wall does not vanish at the same vanishing point as the sun's inclination, the retiring edge of the shadow at c will vanish at the same VP for the corresponding edge of the chimney. The pupil will notice that the building being placed at an angle of 45° with the picture plane, the distance points of the station point are its vanishing points. If the sun's inclination is

directly opposite the eye, the VP for its elevation will be over it, that is, over the point of sight, PS (Fig. 86). Then VPSE is found by drawing the angle of inclination from the distance point of the eye or station point, and the rays of inclination are ruled to the PS.

We advise our pupils to draw the cross and block of Fig. 86 at an angle with the picture plane, retaining the same elevation and inclination of the sun; it will be an exercise for drawing the edges of the shadow of the retiring sides, as previously explained in Problem LII.

Let the position of both be the same as those of Fig. 84, it will be seen how the vanishing edges of the shadows retire to the vanishing points of the solids. All this can be proved by the rays being drawn from the sun's elevation to meet the lines through the angles of the bases of the solids from the sun's inclination; the result would be the same for producing the extent of the shadow as if we drew the retiring edges to the vanishing points. If the shadow projected by a solid crosses a second solid, and partly loses its shadow in that of the second, the rays drawn from the sun's elevation through the angles of the first solid will always determine the extent of the shadow that falls, in the first place, upon the second solid, and determine that part of the shadow upon the ground which is visible, and if necessary also that which is lost; and with regard to the shadow that falls on the second, if we draw perpendicular lines from the points where the lines from the VP of the sun's inclination intersect the edges of the second solid, to its surface, the extent of the shadow falling upon it will be decided. It may occur that the object casting the shadow is inclined: let us suppose that the pole in Fig. 88 is inclined, say at an angle of 40°, the rays from the VP of the sun's elevation must be drawn as usual; but instead of directing the lines that are drawn through the base of the perpendicular pole from the VP of the sun's inclination to intersect those from the elevation, we must first *project the upper end of the pole on the ground* (see Fig. 37, Vol. IV., p. 31, where *f* is the projection of *m*), and draw the line from the VP of the sun's inclination through *the projected point* (*f*) on the ground to meet the ray of elevation drawn through the upper end of the pole; then join the intersection of these two lines with the base of the pole, which will be the shadow. Let the pyramid (Fig. 35, Vol. III., p. 347) be reconstructed, the same rule applies in this case as in that of the pole; for if, after finding the vanishing points for the sun's inclination and elevation, we draw a line from the VPSI through *the centre of the base* (the plan of the vertex) to intersect a line drawn from VPSE *through the vertex*, and join the intersection with the angles at the base, the form of the shadow will be given.

SHADOWS CAST UPON INCLINED PLANES.

Planes or surfaces upon which shadows are cast may be in any position. We have in the previous lessons considered those planes only which are horizontal or vertical, and we now introduce those that are inclined. One or two important and leading principles will first engage our attention.

The indefinite projection of the shadow of a given line coincides with a plane passing through the source of light (the sun) and the given line; this we call *the plane of shade.* Suppose in Fig. 87, S to be the sun, *a b* an object, say a post, casting a shadow, the ray from S through *a* to *c* will determine the length of the shadow *b c* (*see* lesson XVI.); then the space enclosed by *a b c* is deprived of light by the object *a b*, therefore the triangle *a b c* is the plane of shade. When the plane of shade is intersected by any surface, the form and extent of the shadow upon that surface are determined according to the inclination of the surface with the plane of shade. Thus, in Fig. 93 the trace of the plane of the shade of the pole is A B. The pole and its shadow are both lying in this plane; the zigzag form the shadow takes arises from the surfaces (the walls and roofs), which cut this plane, being irregular, or in other words, forming various angles with the plane of shade. To illustrate this change in the direction of the course of the shadow —that is, to show why the shadow of the pole is so angular—let the pupil hold a pencil in an inclined position under a lamp, and allow the shadow to fall upon a slip of cardboard, placing the board first in a horizontal position, then in a perpendicular one, then at an angle with the table, afterwards turn it, so that it shall be parallel with the pencil, he will at once see that according to the position of the cardboard, as it intersects the plane of shade, so will the inclination, position, and length of the shadow be affected, and he will also see the reason for the varied form of the shadow of the pole in Fig. 93. It will now be evident that in order to project the shadows of objects upon inclined planes we must determine the *plane of shade*, which is accomplished *by drawing its trace.* Here a difficulty presents itself—the meaning of *the trace of the plane of shade*, and how it represents the plane. Planes in space in projection *are represented by their traces only.* Thus, in Figs. 88, 89, 90, the traces *h n* and *h c* are the vertical and horizontal traces of the plane *a b c d*; and according to the *positions* of these traces, we understand the positions of the planes. In Fig. 88 the plane is at an angle with

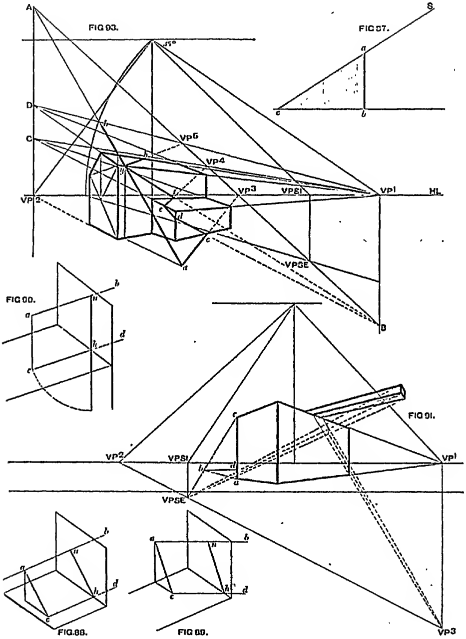


FIG 93.

FIG 87.

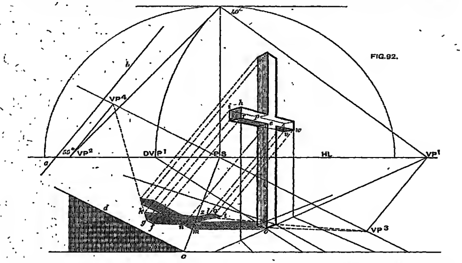
FIG 90.

FIG 91.

FIG.88.

FIG 89.

the ground, and perpendicular to the vertical plane; in Fig. 89 it is at an angle with both planes of projection; in Fig. 90 it is perpendicular to both planes *object upon which the shadow is cast* (the block), meeting at VP[3]. *This is the trace of the plane of shade.* Consequently the shadow from the beam



of projection. In Linear Perspective the line PP, the picture plane, is the horizontal trace of an indefinite perpendicular plane; the line HL, horizontal line, is the vertical trace on the picture plane of a plane passing through the eye and parallel with the ground. To determine the plane of shade we must necessarily project its trace, *by drawing a straight line through the vanishing point of the line projecting the shadow and the vanishing point of the sun's rays;* because both these vanishing points are in the plane of shade. Then the vanishing points for the shadow of a line, projected upon various inclined planes, will be found *upon the trace of shade* at the intersections of the traces of the inclined planes upon which the shadow falls. We shall refer to this again in a problem to illustrate it.

PROBLEM LIII. (Fig. 91) *is a square block of masonry beyond which a beam projects. The sun is in front of the picture.*

It will be observed that a line is drawn from the vanishing point, VP[2], to which the beam, *the object that causes the shadow,* retires, through the vanishing point of the sun's elevation, VPSE, to a perpendicular line drawn from the vanishing point *of the* on the block is drawn in the direction of VP[3],* whilst the rays which determine its length are directed to VPSE. The edge *a b* of the shadow on the ground of the block is directed to VPSI, and its extent cut off at *b* by a ray from *o* to VPSE; *b d,* which is necessary to complete the outline of the visible portion of the shadow cast by the block, is directed towards VP[1].

PROBLEM LIV. (Fig. 92).—*A cross, the face of which is inclined to the PP at an angle of 40°, casts its shadow on a plane inclined at 30° with the horizon; the horizontal trace of the plane is perpendicular to the PP. The sun is in the picture, that is, its rays are parallel with the picture, its elevation 55°; other conditions at pleasure.*

Draw anywhere across the HL the line *a b* at an angle of 55° for the directing ray of the sun's elevation. Draw the line *c d* at 30° with the ground line representing the inclination of the plane

* Because the plane or surface of the block upon which the shadow falls vanishes in a perpendicular line through VP[1]; therefore, any line lying upon that plane will have its vanishing point somewhere in that perpendicular line, according to the angle of inclination; those which are horizontal, like the upper and lower edges of the face, vanish on the HL at VP[1]; VP[3] is in the plane of shade.

receiving the shadow. Draw a line through PS parallel to *o d*; this will be the trace of the inclined plane receiving the shadow, and upon which the vanishing points for the retiring edges of the shadow upon the inclined plane are to be found; thus, draw lines from VP^1 and VP^2 parallel to *a b*, producing VP^3 and VP^4.

The learner will naturally pause here to inquire why these lines should be drawn, and to this query we must reply as follows:—If there had been no inclined plane upon which the shadow falls, the whole of the shadow would have been horizontal, and consequently the retiring lines of the shadow would have vanished on the HL at VP^1 and VP^2 respectively; but as the plane containing the shadow becomes inclined, so will the trace of the plane be inclined also, elevating or depressing the vanishing points proportionately. Construct the perspective elevation of the cross according to previous instructions. The rays from the angles of the cross may be drawn parallel to *a b*; the horizontal projections of the shadow, as *o m*, must be drawn parallel to the PP, as far as the horizontal trace of the inclined plane *c* PS. Afterwards the shadows of the perpendicular edges of the cross which fall upon the inclined plane must be drawn parallel to *c d*, as *m n*, the length of which is determined by the ray *c n*; *n f* is the shadow of *c r*, and is drawn in the direction of VP^3; *f g* is the shadow of *r h* drawn parallel to *c d*, because *r h* is a perpendicular line; *g k*, the shadow of *h i*, is drawn towards VP^4; *k s*, the shadow of *i p*, is drawn towards VP^3. The remaining edges of the shadow upon the inclined plane will not be difficult, if the pupil carefully considers the positions of the lines of the cross; the shadows of those which are perpendicular must be drawn parallel to *c d*; those which would retire, had the shadow been on the ground, to VP^1 must vanish at VP^3; and those which would retire to VP^2 must be directed to VP^4. After the shadow leaves the inclined plane at the horizontal trace *c* PS at *z*, it then falls upon the ground; consequently the edge *z l* will go to VP^1, and the shadow of *r x*, which is *q t*, will vanish at VP^2. The learner should go through this problem three or four times, taking the inclinations of *a b* to the HL and *c d* to the ground line at different angles from those which have been used in this problem.

PROBLEM LV. (Fig. 93).—Again, to show how to determine the vanishing points of shadows which fall upon inclined planes, we have borrowed a subject from "Malton's Perspective." In that work the subject is a ladder inclined against a house; we have chosen a pole, *a b*, instead, to make the explanation more simple. C VP^1 is the trace of the inclined plane of the lower roof, D VP^1 is the trace of the inclined plane of the upper roof. These are found by drawing a line from the vanishing point of the horizonal edge of the roof to the vanishing point of the inclination. (*See* lesson VI., Problem XXXII., Vol. IV., p. 165.) The trace of the plane of the shadow is from A to B, *found by drawing a line from the vanishing point of the object, the pole, casting the shadow, through the vanishing point of the sun's elevation*, VPSE; this contains the vanishing points for the shadow of the pole, projected upon the inclined roofs, and found *where the traces of the inclined planes intersect the trace of the plane of shade*. To begin with the shadow on the ground:—Because this portion, *a e*, is horizontal, therefore its vanishing point is on the HL at VP^3; *e d* vanishes at B, because the plane of the wall containing *o d* vanishes through VP^1; *d c* vanishes at A, the vanishing point of the pole, because the plane of the wall containing *d c* is parallel with the pole; *c f* at VP^4, where the trace of the plane of the roof intersects the plane of shade; similarly, *g h* to VP^5, and *g f* similarly to *c d* at B.

GERMAN.—XXVI.

[*Continued from p. 57.*]

IDIOMATIC PHRASES (*continued*).

Taugen answers to the English phrase "to be good, *or* fit. for," as:—Wozu taugt dieses? what is this good for? (or, more literally, whereto serves this?) Das taugt nichts, that is good for nothing. From this is derived the noun Taugenichts (worthless fellow), as:—Ein langer Schweif von heuchlerischen Taugenichtsen (Wieland), a long train of good-for-nothing fellows.

Große Augen machen (*lit.*, "to make big eyes") is a phrase signifying "to appear surprised *or* astonished."

EXAMPLES.

Es sind ihrer noch einmal so viele als unser.	There are twice as many of them as of us.
Ich habe ihm Geld an'geboten.	I have offered him money.
Geld taugt nicht zu Schneide'werkzeugen, weil es zu weich ist.	Gold is not fit for edge-tools, because it is too soft.
Er machte große Augen, als er mich nach langer Tren'nung wieder erblick'te.	He seemed surprised, as he saw me again, after (a) long separation.

VOCABULARY.

An'bieten, to offer, proffer, tender	An'führung, *f.* leading, conduct, command.	Angriff, *m.* attack, assault.
		Batterie', *f.* battery.
		Bezah'len, to pay.

Dar'bieten, to offer.
Dragoner', *m.* dragoon.
Ein'treten, to enter, step in.
Erschöpft', exhausted, spent.
Erstür'men, to take by storm.
Führer, *m.* leader, commander.
Gulden, *m.* florin, guilder.
Härte, *f.* harshness, unkindness.
Hinaus'springen, to rush out, spring out.
Kreuzer, *m.* a small coin.
Preußisch, Prussian.
Türkisch, Turkish.
Un'billigkeit, *f.* unreasonableness, injustice.
Un'garisch, Hungarian.
Verweich'lichen, to render effeminate.
Verzeh'ren, to consume, eat.
Vor'setzen, to place before, put before.
Wirth, *m.* host, landlord, innkeeper.

EXERCISE 166.

Translate into English:—

1. Die Räuber setzten sich um ein großes Feuer, welches sie in der Mitte des Waldes angezündet hatten. 2. Er setzte sich an den Tisch. 3. Er setzte sich auf sein Pferd, und sprengte zur Stadt hinaus. 4. Die Dragoner saßen alle zu Pferde, und warteten nur noch auf ihren Führer, um den Angriff zu beginnen. 5. Er saß auf seinem Throne so finster und so bleich (Uhland). 6. Wir trafen ihn unter einem Baume sitzend. 7. Der Gast fragte den andern Morgen den Wirth, was er schuldig sei. 8. Er hatte für das, was er verzehrt hatte, einen preußischen Thaler, oder einen Gulden fünf und vierzig Kreuzer zu bezahlen. 9. Dieser Mann ist mir hundert Thaler schuldig. 10. Nachdem er all sein Geld in der Fremde verzehrt hatte, kam er arm und entblößt in seine Heimath zurück. 11. Der Soldat verzehrte die ihm vorgesetzten Speisen mit dem größten Appetit. 12. Sind es ihrer viele, die die Festung vertheidigten? 13. Ja, es sind deren viele, aber es mögen ihrer noch so viele sein, so fürchten wir uns doch nicht. 14. Es waren ihrer etwa hundert, die unter Anführung eines noch jungen Soldaten die Batterie erstürmten. 15. Ein verweichlichter Mensch taugt zu keiner Arbeit. 16. Dieser Beweis taugt nichts. 17. Der ungarische General bot freiwillig dem türkischen Kaiser seine Dienste an. 18. Der Bauer bot dem erschöpften Reisenden einige Äpfel an. 19. Man liest oft in den Zeitungen, es biete sich eine gute Gelegenheit dar, sein Glück zu machen. 20. Er beklagt sich über Unbilligkeit und Härte. 21. Du versagst mir die Freiheit, mich bei dir beklagen zu dürfen. 22. Er wußte nicht recht, wie ihm geschah, und machte bei diesem Ereignisse große Augen. 23. Er machte große Augen, als er den Freund eintreten sah, den er in beinahe zehn Jahren nicht gesehen hatte.

EXERCISE 167.

Translate into German:—

1. This knife is good for nothing; give me another. 2. What you have done is good for nothing. 3. What is a dishonest man good for? 4. These poor people ate the food that was offered them with tho greatest appetite. 5. We read in every paper that Australia offers a good opportunity to make one's fortnne. 6. We were astonished to see our friend, who we believed was in Germany. 7. This man owes me more than twenty ponnds, bnt he says he has paid me. 8. I will pay you, but you cannot prove that I owe you anything. 9. Have you seen your brother to-day? 10. Yes, I saw him sitting under a tree in our garden. 11. The soldiers mounted their horses, and waited for the eignal of their commander to begin the attack.

Es geht, Erst, ETC.

Gehen and zugehen (in the eense "to eucceed *or* get on") are often nsed impersonally, like the English "go," as:—Wie geht es? how goes it? Es geht recht munter zu, they are making very merry.

Erst (first) often anewere to the English "only," "not before," "no more than," "jnst," etc., as:—Es sieht noch so neu aus, als wenn es erst gekauft wäre, it etill looks as new as if it had juet been bought; Die Schule geht erst um zehn Uhr an, the eohool does not begin before ten o'olock; Sie ist erst dreizehn Jahre alt, she is only thirteen years old.

Nächst (next), applied to time, denotes the period nearest at hand; künftig (future, next, ooming) applies to fntnre time, near, or distant, as:—Ich hoffe, in der nächsten Woche dieses Buch beendigen zu können, I hope to be able by (in the) next week to finish this book; Er wird in künftigen Jahren vorsichtiger sein, in coming years he will be more careful.

EXAMPLES.

So geht es in der Welt zu.	So the world goes on.
Es geht seit vierzehn Tagen besser mit ihm.	For a fortnight past it goes better with him.
Erst über's Jahr kann es gesche'hen.	It can only take plaoe a year hence.
Sie ist erst gestern an'gekommen.	She arrived only yesterday.
Niemand weiß, was der nächste Tag mit sich bringt.	No one knowe what the (next day) morrow may bring with it.
Niemand weiß, was die nächsten Tage mit sich bringen.	No one knows what the next days may bring with them.
In dem künf'tigen Jahre be'suche ich wahr'scheinlich die Schweiz.	In the coming year I shall probably visit Switzerland.
Dies war die nächste Ur'sache seiner Ab'reise.	This was the immediate (nearest) cause of his departure.
Er hat den Auftrag besorgt'.	He has attended to (done) the commission.
Er besorgt' seine Geschäfte selbst.	He attends to (does) his business himself.

Man versorg'te den Fremden mit Allem, was er nöthig hatte.	The stranger was provided (supplied) with all that he needed.

Vocabulary.

Besor'gen, to manage, attend to, take care of.
Gelin'gen, to succeed, prosper, speed.
Geschäf'tig, busy, busied, active.
Häuslich, domestic.
Himmlisch, heavenly, celestial.
Hin'länglich, enough, sufficiently.
Hin'setzen (sich), to sit down.
Irdisch, terrestrial, earthly.
Le'bensmittel, *pl.* provisions, victuals.
Un'überlegt, inconsiderate, rash.
Ver'sorgen, to provide.
Vorbei', past, gone.
Zeitlich, temporal, earthly, timely.

Exercise 168.

Translate into English:—

1. Erst nahm er Papier und Federn, dann setzte er sich hin, um zu schreiben. 2. Er hat eben erst angefangen zu arbeiten. 3. Es ist erst sieben Uhr vorbei. 4. Dieser Knabe ist erst dreizehn Jahre alt. 5. Nun ging es erst recht arg zu. 6. Es ist eine halbe Stunde weit bis zum nächsten Dorfe. 7. Dies ist der nächste Weg dahin. 8. Ich will ihm mit der nächsten Post schreiben. 9. Ein unüberlegtes Wort ist zuweilen die nächste Ursache zu Streit und Hader. 10. Mein Freund kommt die nächste Woche hierher. 11. Im künftigen Jahre gedenkt er nach Amerika zu reisen. 12. In künftigen Jahren werde ich vorsichtiger sein. 13. Künftige Woche gehe ich einige Tage auf's Land. 14. An das künftige Leben sollten wir mehr denken, als an das zeitliche. 15. Mein künftiges Leben soll dir gewidmet sein. 16. Ich befürchte, es wird auf diese Weise nicht gelingen. 17. Er sorgt mehr für irdische, als für himmlische Reichthümer. 18. Die geschäftige Frau besorgt alle häuslichen Arbeiten selbst. 19. Der Nachbar besorgte mir den Brief auf die Post. 20. Der Auftrag wurde von dem kleinen Knaben pünktlich besorgt. 21. Die Festung wurde hinlänglich mit Lebensmitteln versorgt. 22. Der Bruder versorgte mich zeitig mit guten Büchern. 23. Der arme Mann hat sechs Kinder zu versorgen.

Exercise 169.

Translate into German:—

1. First I shall read, then I shall write. 2. I returned from my journey only yesterday. 3. I shall not see him till to-morrow. 4. I have received only half of my books. 5. We ought first to avoid doing evil, and then to do good. 6. Next spring I shall probably go into the country for a few days. 7. Are you sufficiently acquainted with the circumstances of his immediate departure? 8. That errand was punctually performed by this man. 9. This poor woman has five children to provide for. 10. I sometimes provide him with an instructive book. 11. Next time I shall be more careful.

Einholen, Heute, etc.

Einholen (from ein, *in*, and holen, *to fetch*) signifies "to go to meet," "to overtake," "to outrun," etc., as:—Eine Deputation holte den Gesandten ein, a deputation went out to meet the ambassador; Nach drei Tagen hatte unsere Fregatte das feindliche Schiff eingeholt, after three days our frigate had overtaken the hostile ship.

Heute, "to-day" (Latin *hodie*), is sometimes best rendered "at the present," "now," etc., as:—Heut zu Tage, or Heutiges Tages, at the present day, nowadays; Unsere Sitten werden der Nachwelt einst eben so erscheinen, wie uns heut zu Tage die unsrer Vorfahren, our customs one day will appear to posterity just as (do) those of our ancestors to us at the present day; Die Goldgier treibt heutiges Tages viele Tausende nach Californien, the immoderate desire for gold drives, at the present day, many thousands to California.

Examples.

Er wünschte mir eine an'genehme Reise.	He wished me a pleasant journey.
Ich geden'ke frü'herer Zeiten, und gedach'te Ihrer oft während meiner Krankheit.	I remember former times, and thought of you often during my sickness.
Ich geden'ke seinen Fleiß zu beloh'nen.	I intend to reward his diligence.
Er gedach'te mir ein Leid zu thun.	He designed to do me an injury.
Ich bin nicht geson'nen darein' zu wil'ligen.	I do not intend to agree to it.
Ich packe meinen Koffer, weil ich geson'nen bin in ei'nigen Tagen eine Reise an'zutreten.	I am packing my trunk, because I intend in a few days to go on a journey.
Er ist im Begriff', nach A'sien zu reisen.	He is on the point of going to Asia.
Gustav Adolph führte seine Schweden von Sieg zu Sieg, und erkauf'te den bei Lützen mit seinem Leben.	Gustavus Adolphus led his Swedes from victory to victory, and purchased the one at Lützen with his life.
Der Blitz'ableiter ist eine wich'tige amerika'nische Erfin'dung.	The lightning-rod is an important American invention.

Vocabulary.

Ab'leiten, to turn off, derive.
A'larich, *m.* Alaric.
Angst, *f.* anxiety.
Be'graben, to inter, bury.
Begriff', *m.* conception, notion (im Begriff' sein, to be on the point).
Busen'to, *m.* Busento (river in Italy).
Erler'nung, *f.* learning, acquisition.

Gesonnen sein, to be inclined, to intend.
Gothe, m. Goth.
Innig, heartfelt, hearty.
Leiten, to guide, lead, conduct.
Packen, to pack, pack up.
Richtplatz, m. place of execution.
Strömung, f. streaming, current, flood.
Verreisen, to go on a journey, travel, set out.
Zuvor, before.

EXERCISE 170.

Translate into English:—

1. Ich wünsche Ihnen einen guten Morgen. 2. Ich habe die Ehre, Ihnen einen guten Morgen zu wünschen. 3. Ich gedenke meiner Freunde mit inniger Liebe. 4. In den Zeiten des Glückes gedachte er seiner nicht, wohl aber in den Stunden der Angst und Noth. 5. Ich gedenke zu verreisen. 6. Ich gedenke bald wieder zu kommen. 7. Wir gedenken zu verreisen. 8. Ihr gedachtet es böse mit mir zu machen. 9. Der Vater ist gesonnen, darein zu willigen. 10. Ich war nicht gesonnen, dahin zu gehen. 11. Ich packe meinen Koffer, weil ich gesonnen bin, in den ersten Tagen zu verreisen. 12. Ich stehe im Begriffe, abzureisen. 13. Ich bin im Begriffe, auszugehen. 14. Man führt den Verbrecher zum Richtplatze. 15. Der Sohn des Herzogs führte die Truppen selbst zum Sturme. 16. Er führte sie zum Angriffe. 17. Rußland führte Krieg mit Polen. 18. Der Kaufmann führt Waaren zum Markte. 19. Ein kleines Kind leitete den blinden Mann. 20. Alarich wurde von den Gothen in dem Busento begraben, nachdem sie zuvor die Strömung abgeleitet hatten. 21. Er leitet einen Jeden nach seinem Rath. 22. Wer sich nicht von der Vernunft leiten läßt, der läuft Gefahr, daß ihn seine Leidenschaften in's Verderben führen. 23. Der fleißige Schüler holte seine Cameraden bei der Erlernung der englischen Sprache noch ein, obgleich dieselben beinahe vier Wochen eher angefangen hatten. 24. Wir holten die Freunde auf ihrem Wege noch ein, obgleich sie eine halbe Stunde früher fortgegangen waren. 25. Heut zu Tage erreichen die Menschen kein so hohes Alter mehr, als in früheren Zeiten. 26. Man hört heut zu Tage von nichts Anderm sprechen, als von Krieg. 27. Man hört heutiges Tages viel klagen über schlechte Zeiten.

EXERCISE 171.

Translate into German:—

1. I wish you a good evening. 2. I have the pleasure to wish you a good morning. 3. When in foreign countries, we often remember with affection our friends at home. 4. I intend to go next month to the Continent. 5. Do you intend to remain long there? 6. No, I do not intend to remain long there; I shall soon return. 7. He tried to overtake his friend in learning the German language, but he could not, as his friend was too far advanced. 8. Do you intend to overtake your brother on his journey? 9. I overtook my brother after three days' journey. 10. Six months ago I was on the point of going to America, but now I am very glad I remained at home.

KEY TO EXERCISES.

Ex. 156.—1. The accident has happened, and it cannot be altered. 2. When did he meet with this accident? 3. It happened an hour ago. 4. What can be done shall be done, to procure a better situation for these people. 5. It has frequently been the case that confidence has been abused. 6. In former times more wonders and signs took place than in the present time. 7. It served him right to have once received a chastisement. 8. Without the knowledge and will of God nothing comes to pass. 9. The idler does not know what to do. 10. The diligent boy did not know what else to do. 11. The gaoler asked what he must do to be saved. 12. How do you like the vegetables? 13. I like them very much. 14. Do you not like this cake? 15. Oh, yes; I like it very much. 16. Do you like the dinner? 17. No, doctor; everything tastes bitter. 18. It is I who speak and have spoken this. 19. It is he who ventured to speak these words. 20. It is you, is it not, who have said that they should liberate the prisoners?

Ex. 157.—1. Wann ist Ihrem Freunde das Unglück begegnet? 2. Es geschah gestern; er weiß nicht, wie er dasselbe überwinden soll. 3. Wir wollen Alles versuchen, seine Stellung zu verbessern. 4. Wenn die Umstände dieser Leute zu ändern wären, so würde Alles mit denselben gut gehen. 5. Es ist schon oft der Fall gewesen, daß seine Güte mißbraucht worden ist. 6. Die Strafe, welche diese faulen Knaben empfingen, geschah ihnen recht. 7. Geschehe was da will, ich werde auf Gott vertrauen. 8. Was geschehen ist, ist nicht zu ändern, und was gesagt worden ist, kann nicht ungesagt gemacht werden. 9. Schmeckt Ihnen Ihr Essen? 10. Nein, Herr Doctor, mir schmeckt nichts, Alles schmeckt mir bitter. 11. Es war mein Freund, der diese Worte sprach, man möchte diesen armen Auswanderern beistehen. 12. Was hat Ihnen Ihr neuer Wagen gekostet? 13. Er hat mir fünfzig Guineen gekostet. 14. Haben Sie schon diesen Kuchen versucht? 15. Ja, aber er schmeckt mir nicht, haben Sie andern?

Ex. 158.—1. He gave him a blow in the face. 2. My sister playfully gave me a blow with the palm of her hand. 3. It does not become boys to strike one another. 4. Father is gone on a pedestrian tour, and will not return before evening. 5. My brother was in the field this morning in order to look at the corn, and this afternoon he is going into town to see his sick cousin. 6. How did you come by this gold piece? 7. I found it as I was going to the field. 8. It is not known how this man came by his riches. 9. Rich people live in town in winter, and in the country in summer. 10. When rich and proud citizens come into the country, they are fond of ridiculing the homely and simple manners of its inhabitants. 11. Louis XVI. was captured just on the frontiers of France, through the treachery of a postmaster. 12. The thief was taken by the night-watch, as he was going to run out of the house. 13. It was not known for a long time who the strangers were, until it was discovered that they were political refugees. 14. At last, what had been covered by the veil of secrecy for many years has come to light. 15. Before he got in the carriage with me, he made it a condition that I should drive slowly. 16. When he was asked why he had committed this degrading deed, he replied that distress had driven him to it. 17. Hereupon I answered him, that want was no reason for theft, and distress was no reason for crime. 18. Fortune removed him from affluence to the greatest poverty, as it often removed me from one position to the other, from one

country to the other, and from one part of the globe to the other; but the severest blow it gave me was, that it allowed my brother to die on the day of my arrival in America.

Ex. 159.—1. Mein Bruder geht Morgen früh mit seinem Freunde über Land, und wird am Abend zurückkommen. 2. Wie kamen Sie zu diesem Buche? 3. Ich fand es, als ich über Land ging. 4. Der Vater versetzte dem Knaben einen Schlag mit der Hand. 5. Auf die Fragen, welche der Richter an den Verbrecher that, versetzte er, daß er das Verbrechen nicht vorsätzlich begangen habe. 6. Ich bin seit langer Zeit nicht in Deutschland gewesen. 7. Ich bin nicht lange in Deutschland gewesen. 8. Es ist lange her, daß ich meine Eltern und Brüder gesehen habe. 9. Lange nachdem sich sein Bleistift gefunden hatte, wußte er nicht, wer es genommen hatte. 10. Laß uns über Feld gehen, da wir heute schönes Wetter haben? 11. Wie lange ist es her, daß Sie etwas von Ihren Freunden gehört haben? 12. Ich weiß es nicht, aber ich glaube, es ist länger als ein Monat, seitdem ich etwas von ihnen gehört habe.

Ex. 160.—1. Both friends were tired of disputing longer with each other. 2. The king and the empress, wearied with the long quarrel, at last made peace. 3. As the wind blew tolerably hard and without cessation, we already saw land after fourteen days. 4. A very cold wind is blowing to-day, and I am afraid that we shall have snow. 5. The wind has much abated since dinner-time; it does not blow so hard by far as it did this morning. 6 There was such a cold and chilling air blowing, that it chilled both his hands within five minutes. 7. Is my father still alive? 8. Yes, he is still living, but our young friend is no more. 9. It is well for him; he is gone where there is no more snow. 10. He, the sustainer of so many poor people, is no more. 11. On what does this poor family live? 12. What is talked of? 13 Of whom do they speak? 14. That is something which you do not understand. 15. What is the conversation about? 16. Of whom have you heard this? 17. From whom have you received this fine present? 18. The poacher shot at the gamekeeper, but the ball missed its aim; and before he could fire another shot, he himself fell, hit by the gamekeeper's shot. 19. The fortress was surrendered without a shot, and without a sword being drawn. 20. He shot several times in the garden to frighten away the birds.

Ex. 161.—1. Sie werden mit Ihrem Bruder Schritt halten, wenn Sie fleißiger sind. 2. Geh Schritt für Schritt, und Du wirst Dein Ziel nicht verfehlen. 3. Von wem haben Sie dieses Geschenk empfangen? 4. Wovon ist es gemacht? 5. Von wem ist es gemacht? 6. Lebt meine Mutter noch? 7. Ja, sie lebt noch; aber mein Vater ist nicht mehr 8. Wohl ihm, er ist hingegangen, wo keine Sorgen mehr sind. 9. Es weht heute ein sehr rauher Wind, und deßhalb ist es besser, zu Hause zu bleiben 10. Ich glaube, wir werden Regen bekommen, wenn der Wind sich legt. 11. Gehen Sie ja nicht aus, denn die Luft ist sehr schneidend, und ich fürchte, daß Sie sich die Hände erfrieren werden. 12. So lange der Wind im Osten ist, wird es kalt und trocken bleiben. 13. Des langen Haders endlich müde, machte ich Frieden mit meinen Freunden.

Ex. 162.—1 A patriot would rather die than become a traitor. 2. The first Christians preferred suffering the severest persecutions to forsaking their belief. 3. One does not suffer such a thing to be told him twice. 4. I have not seen one of my brothers for three years. 5. A friend of mine was drowned some years ago in the Danube near Vienna. 6. To travel is good, if one has money; and to live agreeable, if one has no cares. 7. It is better to live in a free country than in a despotic one. 8. It is pleasant to travel in the society of lively friends. 9. In prosperity man but too easily forgets what he is. 10. Many distinguished and noble men have been forgotten. 11. It should not satisfy a man to know what is right, but he ought also to endeavour to do right. 12. It affords me satisfaction to know that you are all still well. 13. How little is often sufficient to make a man happy! 14. He handed him the paper after he had read it himself. 15. This was sufficient to satisfy him. 16. The cook prepares the food. 17. He has produced this little confusion on purpose. 18. The cook tasted the soup before she served it up. 19. We must try if we cannot help him yet. 20. Just taste this wine (to see) if it is sweet enough. 21. He told me to remember him to you.

Ex. 163.—1. Ich habe eben einen Bruder von Ihnen gesehen, welcher von Indien zurückgekommen ist. 2. Ein Freund von mir verheirathete sich vorige Woche. 3. Der Lehrer hat mir die Erklärung dieses Gegenstandes aufgetragen. 4. Hat mein Vater Ihnen aufgetragen, Ihren Bruder heute Abend zu uns einzuladen? 5. Nein, mein Herr, aber er hat mich beauftragt, meinem Vater zu sagen, daß er ihn Morgen früh besuchen könnte. 6. Der Schüler reichte ihm, auf das Gesuch des Lehrers, das Buch. 7. Reichthümer reichen nicht hin, einen Menschen glücklich zu machen. 8. Ein wahrer Christ erduldet lieber große Leiden, als daß er seinen Glauben verriethe. 9. Ist das Essen schon aufgetragen? 10. Nein, mein Herr, es ist noch nicht aufgetragen; es ist noch nicht angerichtet. 11. Einem klugen Manne genügt es nicht, zu wissen, was recht ist, sondern er handelt auch recht.

Ex. 164.—1. The sick man will not eat anything, notwithstanding he has been advised by the doctor. 2. He has eaten but very little with us. 3. My brother has recovered from his illness. 4. The recovery of this sick man progresses but slowly. 5. The church service commences at half-past ten in the morning, and is generally closed at half-past eleven. 6. He made him his most intimate friend, without having proved him beforehand, or otherwise having an evidence of his fidelity and silence. 7. Do not choose every one as a confidential friend; the empty house is open—the rich one closed; . . . . choose only one, and seek not another; what is known to three will soon reach everybody. 8. Is it probable that you will come to me for a short time this afternoon? 9. Are you likely to come to the concert this evening? 10. He lives as he pleases; he depends on nobody. 11. He rises when he pleases in the morning; at one time early, at another time late. 12. He speaks and acts as he pleases, without caring for the judgment of the people. 13. I accidentally found him at home. 14. I accidentally met him at the theatre. 15. It is indeed not so easy to adapt one's self patiently to all conditions of life. 16. What this woman has said is quite true. 17. What nobody ventured he has accomplished. 18. He has accomplished the thing. 19. The child fell asleep through weariness. 20. The company got very tired, and they separated early. 21. He wearied not only me, but also my friends.

Ex. 165.—1. Warum haben Sie das Fenster geöffnet? 2. Es ist so sehr warm in dem Zimmer, und ich genieße gern die frische Luft. 3. Ich bitte Sie, machen Sie das Fenster zu,

und die Thür auf. 4. Schließe die Thür, damit das Fenster auf sein kann. 5. Ich weiß in der That nicht, was ich mit diesem meinem Sohne thun soll; er will nicht auf meinen Rath horchen. 6. Die meisten seiner Zuhörer schliefen während seiner langen Rede ein. 7. Ein gutes Werk kann nur durch Aufmerksamkeit zu Stande gebracht werden. 8. Die Genesung meiner Tochter schreitet nur langsam fort; sie will nichts genießen, trotzdem es der Arzt ihr angerathen hat.

HYDRAULICS.—VI.

[Continued from p. 61.]

WATER IN STEADY MOTION.

DISCHARGE THROUGH ORIFICES—HEAD OF WATER—HEAD LOST IN FRICTION—VELOCITY OF FLOW—VENA CONTRACTA—QUANTITY OF WATER DISCHARGED THROUGH SLUICES AND OTHER ORIFICES—STEADY FLOW OF WATER IN PIPES—VELOCITY OF FLOW AND PRESSURE IN PIPES—JET PUMP—INJECTORS.

HEAD OF WATER.

IN lesson III., Vol. III., p. 317, we considered the tendency of water to flow freely under the action of gravity from places of higher to places of lower level. If the water be at rest in the highest position, say h feet above a horizontal plane, we may say it has h feet of *head* relative to this datum plane, and every pound of the water has, in virtue of this elevation, h foot-pounds of potential energy stored up in it. Thus, at the free-surface level A, Fig. 14, the water is said to have h feet of *head* above the small discharge orifice in the vessel. If a pound of such water were allowed to fall freely through h feet to the datum level, under the action of gravity, it could do h ft.-lb. of work in falling. Suppose the water at the atmospheric pressure at A, Fig. 14, is allowed to flow out of the small orifice, it will flow along certain stream lines, as indicated, and the shape of these lines will largely depend on the relative size and shape of the orifice and the head of water.

The pressure at B around the jet, where it comes into contact with the atmosphere as it issues from the orifice, is simply atmospheric pressure, and therefore the same as at the free still-water surface A in the vessel; therefore any energy the water may have, owing to its pressure merely, is the same at both places, though this may not be the case with the particles of water in the interior of the jet, nor in their path from the free surface down through the mass of water, until, leaving the orifice, the water again comes in contact with the atmosphere. Thus, at A and B the free exposed surface of the water is at atmospheric pressure, and the pressure-energy stored up in the water is the same at both places. But at B the water has fallen h feet, and, neglecting friction for the moment, we are in a

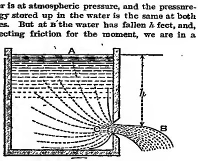


Fig. 4.

position to calculate the velocity v of the jet due simply to the difference of level between the free surface in the reservoir at A and the orifice at B. In falling h feet one pound of water loses h ft.-lb. of potential energy, which has all been converted into kinetic energy, so that owing to its acquired velocity, the water at B has gained h ft.-lb. of kinetic energy. Now, we have seen, Vol. III., p. 317, that the kinetic energy of a mass of w lb., moving with a velocity of v feet per second, is

$$\frac{wv^2}{2g} \text{ foot-pounds;}$$

so that if we let v feet per second be the velocity of 1 lb. of water, in this case at B, we may find the value of v, since the kinetic energy gained must be equal to the h ft.-lb. of potential energy lost.

In other words, neglecting friction, we have at B

$$\frac{v^2}{2g} = h \text{ ft.-lb.,}$$

so that

$$v^2 = 2gh = 64{\cdot}4h,$$

and

$$v = \sqrt{64{\cdot}4\,h} = 8{\cdot}025h \text{ feet per second.}$$

Therefore, the velocity of the water leaving the orifice at B, v feet per second, calculated in this way, is just the same as that of a heavy body, like a stone, which has fallen freely through h feet, since for both $v = \sqrt{2gh}$.

However, there is always loss in overcoming the frictional resistance between the water and the orifice, so that the actual velocity of discharge is less than $\sqrt{2gh}$; in fact, for well-formed orifices, with clean, sharp, bevelled edges, we may take the actual velocity of jets about

$${\cdot}97 \times \text{calculated velocity} = {\cdot}97\ \sqrt{2gh}.$$

A numerical example will make this clear.

EXAMPLE 1.—The free-surface level of water in a reservoir is 20 feet above a small circular orifice in a thin plate, from which the water flows into the atmosphere. What is the velocity of the particles of water of the issuing jet in contact with the atmosphere?

Here, as at B, Fig. 14, the pressure on a particle of water at the outside of the jet is that of the atmosphere, and therefore the same as at the free-surface level of still water at A. Consequently, so far as regards *pressure*, the energy stored up in the water would be the same at both places. But at A the water was elevated and motionless, whereas at B it has acquired a velocity, due to the height it has fallen through. Now, one pound of water in falling 20 feet difference of level has lost 1×20, or 20 ft.-lb., of potential energy, which is changed into kinetic energy, or energy due to motion. If we let v stand for the velocity of the water at B due to the height of 20 feet fall, we know that the kinetic energy of 1 lb. weight of it is

$$\frac{1 \times v^2}{64 \cdot 4} = 20 \text{ ft.-lb.},$$

hence

$$v^2 = 20 \times 64 \cdot 4 = 1288,$$

so that

$$v = \sqrt{1288} = 35 \cdot 9 \text{ feet per second, nearly}$$

However, we find from experiment that the whole potential energy is not entirely converted into kinetic energy, part of it being lost in friction, and there is, consequently, a falling off in the velocity due to this loss, the actual velocity being only a fraction, ·97 of the calculated velocity 35·9 feet per second for the particular kind of orifice we are dealing with. Therefore, the real velocity of the outside layer of water in the jet flowing into the atmosphere is

Required velocity $= \cdot 97 \times 35 \cdot 9 = 34 \cdot 8$ feet per second. *Answer.*

QUANTITY OF WATER DISCHARGED THROUGH SLUICES.

As regards the *quantity* or volume of water discharged through a sluice or other orifice beneath the surface, if we know the *area* of the orifice and the *actual velocity* v of discharge, at first sight it would appear that the volume Q of water passing in cubic feet per second would be

$$Q = \textit{cross sectional area of orifice} \times \textit{velocity of discharge},$$

where the cross section of orifice is reckoned in square feet, and the velocity in feet per second.

But experiment shows that the issuing jet is much less in section than the area of the orifice. For a sharp-edged circular orifice in a thin plate, as shown in Fig. 14, the jet contracts in section to about $\frac{5}{8}$ths of the area of orifice, so that we have the quantity of water discharged in cubic feet per second—

$$\begin{aligned} Q &= \text{actual section of jet} \times \text{its actual velocity}, \\ &= \cdot 64 \times \text{area of orifice} \times \cdot 97 \sqrt{2gh} \\ &= \cdot 62 \times \text{area } \sqrt{64 \cdot 4h} = \cdot 62 \times 8 \cdot 025a\sqrt{h} \\ \therefore Q &= 5a\sqrt{h}; \end{aligned}$$

where Q stands for cubic feet of water passing per second,
„ a „ „ area of orifice in square feet,
and h „ „ effective head in feet.

In other words, we have the rule to calculate the discharge through a sluice or round sharp-edged orifice:—*Five times the cross sectional area of the orifice in square feet multiplied by the square root of the depth of orifice in feet, gives the cubic feet of water flowing through per second.*

EXAMPLE 2.—A round sharp-edged orifice ·3 inches in diameter is 16 feet below the free surface of still water. How much water is leaving per second (1) in cubic feet, and (2) in gallons?

Here we have the necessary data to substitute values in our formula

$$Q = 5a\sqrt{h}.$$

First of all, the diameter of the orifice is 3 inches or $\frac{1}{4}$ foot, and therefore for cross sectional area we have

$$a = \frac{\pi}{4} d^2 = \frac{3 \cdot 1416}{4} \times \frac{1}{4^2}$$

$$\therefore a = \cdot 7854 \times \frac{1}{16} = \cdot 04909 \text{ sq. ft.}$$

Again, the *head* is 16 feet, so that

$$\sqrt{h} = \sqrt{16} = 4.$$

Hence the discharge of water is at the rate—

$$\begin{aligned} Q &= 5 \times 4 \times \cdot 04909 \\ &= 0 \cdot 9818 \end{aligned}$$
or Q = 1 cubic foot per second, nearly.

The weight of water leaving the orifice is

$$\cdot 9818 \times 62 \cdot 3 = 61 \cdot 15 \text{ lb. per second},$$

and since 10 lb. of water go to the gallon, this comes to a little over 6 gallons of water discharged per second. *Answer.*

HEAD LOST IN FRICTION.

Another method is to reckon h as the height of the level of still water above the centre of the orifice, and then deduct a certain fraction from the head for loss in friction. Thus, by effective head is meant that part of the total height which corresponds to the actual velocity of discharge, whilst the other part of the total height of fall is spent in overcoming the resistances offered to the flow of water as a perfect fluid, and these resistances are due mainly to friction at the nozzle or orifice, though also due in part to the viscosity—that is, the internal friction amongst the particles of water themselves.

The falling off in head due to friction may be found experimentally by means of a narrow conical orifice opening upwards, so that the water as it flows out of the vessel or reservoir is projected vertically upwards by the pressure inside the vessel. We know that if a tall glass tube were attached to the orifice, the water would rise to the same height in this tube as in the vessel, just like water at rest seeking its own level in the two branches of a U-shaped tube. However, when the water is allowed to flow through the orifice into the atmosphere, it is found that the jet does not rise to the same height as the level of the free surface of still water in the vessel from which it flows. This difference of level between the top of the jet and the free surface of still water inside the vessel is the loss of head expended in overcoming the frictional resistance to flow, which occurs principally at the nozzle or mouthpiece inserted in the orifice. In fact it may be proved that the head lost in friction is proportional to the kinetic energy of the water at the nozzle, but the exact amount of such loss can only be obtained by experiment. If h' stands for the loss of head due to friction—that is to say, h' is the difference of level between the highest point the jet is found to reach and the level of free surface of still water inside the vessel, or the distance the top of the jet falls short of this level; let h be the depth of the nozzle below still water level, then the fraction

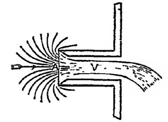


Fig. 15.

$\frac{h'}{h}$ of the whole kinetic energy at the nozzle

is the loss due to friction. The energy wasted per second in overcoming friction is equal to the *force* of friction multiplied by the *velocity* per second, and experiment shows that the *force* of friction in water is proportional to the velocity when the velocity is small, but increases as the square, and even the cube of the velocity in the case of quick motion. For water flowing at comparatively slow velocity through orifices or pipes we may take the *force* of friction directly proportional to the velocity, so that the energy wasted or lost per second in overcoming friction is proportional to the square of the velocity.

In fact, the so-called "loss of head" of the books is really loss of energy per pound of water due to friction, and we have

$$l = F\frac{v^2}{2g},$$

where F is a number or coefficient depending on the form or nature of the passage through which the water flows, and the greater the kinetic energy the greater the loss. For a thin-edged circular orifice in a thin plate F = 054, whereas if the orifice has a short cylindrical tube or mouthpiece F = 0·505, and the head lost will then be

$$\cdot 505\,\frac{v^2}{2g}.$$

Consequently in practice we must always allow for the difference between the real velocity of discharge, and the calculated velocity due to the head of elevation reckoned above the orifice

VENA CONTRACTA.

The other factor in the expression for the quantity of water flowing through an orifice is the cross-sectional area of the jet. Experiment shows that the amount of contraction in the issuing jet depends on the shape of the orifice, nozzle, or mouthpiece through which the water flows, as well as on the head, or height of the level of the free surface of still water above the orifice. When the orifice is small compared with the head, the water flows at right angles to the cross section of the jet, or the stream lines are all parallel, at the most contracted part V, Fig 15, of the jet as it issues just outside the orifice. The *area* of the jet at this narrowest part is called the *vena contracta*.

In the special case of the re-entrant mouthpiece, Fig. 15, fixed in the orifice, the greatest possible contraction occurs, and the area of the contracted jet at V, or the *vena contracta*, is only half the area of the mouthpiece A. This limiting value of greatest contraction in this extreme case may readily be determined theoretically, and it has been confirmed experimentally that the coefficient of discharge is about 0·5.

Hence, the volume of water discharged through this mouthpiece is

$$Q = \cdot 5a\sqrt{2gh},$$
$$\therefore Q = 4a\sqrt{h},$$

where Q stands for cubic feet of water discharged per second,
„ a „ „ cross sectional area of orifice in square feet,
and h „ „ height of free-surface level in feet.

In other words, the *quantity of water discharged* through this mouthpiece *is equal to four times the cross-sectional area of the orifice in square feet multiplied by the square root of the head in feet.*

STEADY FLOW OF WATER IN PIPES.

Suppose we have a pipe A B, Fig. 16, laid in a horizontal position so that the centre line is exactly at the same level all along the pipe, and differences of level may be neglected. Let water be delivered by this pipe at a steady rate from a reservoir provided with a constant supply which keeps the free-surface level always the same. If the pipe A B is of uniform sectional area throughout, and at all points offers a uniform frictional resistance to the flow of the water, the pressure will gradually become less its value at A because of the work spent in overcoming the frictional resistance of the pipe. The heights to the dotted line give the values of the pressure along the pipe as found by experiment. This is evident, since the water exerts the same pressure all round the pipe at any section normal to the sides of the pipe, and therefore the pressure represented by the column of water in any one of the gauge tubes is the pressure in the water at that point along the pipe. Moreover the same result becomes evident from two different lines of thought.

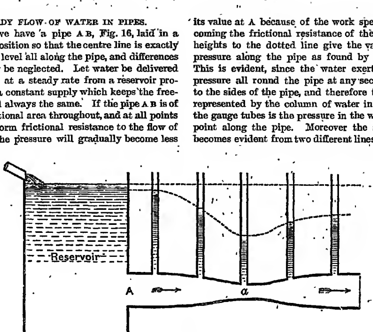


Fig. 16.

at points along it more and more distant from the reservoir. This is no longer the case when the pipe is larger at one place than another, as shown in Fig. 16. When there is a steady flow of water along such a pipe, there must be the same quantity of water flowing everywhere, and passing every section in a given interval of time. The pipe is filled with water at every part, and therefore the quantity of water passing every section per second is

Q = cross section of pipe × velocity of flow.

There must be greatest velocity at *a*, where the pipe is narrowest, in order to allow the same quantity of water through it per second as at A or B, where the passage is larger. Hence, the velocity increases as the pipe becomes narrower, or

velocity of flow varies inversely as section of pipe.

Further, the *pressure is found to be least where the sectional area of the pipe is least.* This may be proved experimentally by inserting a number of gauge tubes in the pipe, as shown in Fig. 16; and the height to which the water rises in each tube measures the pressure in the pipe at that point. As the pipe gradually tapers from A to *a* the pressure becomes less; and, again, as the pipe widens from *a* to B the pressure increases, but never reaches

As a particle of water passes from A to the contracted part *a* of the pipe, we see that the velocity of flow increases, and consequently the resistance to the forward motion of the particle must have become less. Hence, the pressure of the water behind the particle at A urging it towards *a* must be greater than the pressure in front of it at *a* opposing its advance. When flowing from *a* to B, the velocity of the particle is again checked and lessened, consequently the pressure in front of it at the wide part B of the pipe, must be greater than the pressure behind the particle in the narrow pipe *a*.

This quite agrees with the fundamental law for the total store of energy in a given quantity of water. Because the pipe is horizontal, the potential energy of the water in it due to height above any datum level is the same everywhere. Therefore the sum of kinetic energy + pressure energy must be constant. But the greater velocity means greater kinetic energy at the narrow part *a* of the pipe, and since the total store of energy in every pound of the water remains constant, if we neglect the loss by friction, the pressure energy must be less at *a* than at A or at B. That is, the pressure of the water in the pipe at *a* is less than at A or at B.

In a conical piece of pipe like A *a*, one end of

which is larger than the other, with a steady flow of water in it, there is undoubtedly a force tending to cause motion of the pipe. This is evident, because the pressure per square inch at A is greater and the area of A is greater, therefore the total force with which A is acted on is greater than that at *a*. However, the other part of the pipe *a* B enlarges again to the same size at B, and the resultant force on the part *a* B exactly balances the resultant force on the part A *a*, hence there is no tendency to move the whole pipe by a steady flow of water through it.

JET PUMP AND INJECTORS.

By making the cross section of the pipe at *a* smaller, the velocity of flow of water may be increased, and the pressure still further reduced. In this way it is easy to reduce the pressure at *a* much below atmospheric pressure, by merely contracting the bore of the pipe and increasing the velocity of flow at that part of the pipe. Owing to the partial vacuum thus formed at *a* there will be suction towards this part of the pipe. This is the principle underlying the action of the jet pump and injectors of various kinds. The

Jet Pump

simply consists of a pipe A, Fig. 17, ending in a nozzle at *a*, through which water flows or is injected from a high cistern or reservoir, and flows through the discharge pipe C into the atmosphere. We have seen that the pressure at *a* is much less than the pressure at C, which is that of the atmosphere. Thus the space around the nozzle *a* is a partial vacuum, so that water or other fluid is thereby sucked and drawn up a pipe B opening into this space, whence it is made to flow away by the discharge pipe C. The fluid to be pumped is lifted or drawn up the *suction pipe* B into the partially vacuous space at *a*, whilst the flow of water under pressure from the high cistern through the nozzle A*a* carries the whole through the discharge pipe

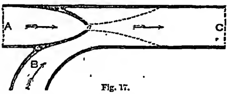


Fig. 17.

to C. Thus the energy in the water supplied at the high cistern may be utilised to pump or lift up water.

Again, by means of a tapering nozzle, steam may be injected into a conical mouthpiece, drawing in with it any required proportion of air or other gaseous fluid from the surrounding space. On this simple principle of suction, injectors have been devised for many useful purposes.

ENGLISH.—XXVI.

[Continued from p. 63.]

CONSONANTS (*continued*).

PALATALS.

NEXT let us pass on to the palatal consonants, and here we get into a larger field. The only palatals we have so far mentioned are *s* and *t*, a continuant and an explosive respectively; but there are many more, and it will be an advantage to deal first with only the continuant palatals. Thus taking *s* as a starting-point, pronounce in succession *s* in *see*, *sh* in *shall*, and *ch* in the German *ich*. If the student gets the sounds correctly, he will find that his tongue is successively receding towards the back of his mouth, but that each time the sound is formed by contact between the tongue and the palate. Now let him repeat the experiment with the corresponding voiced sounds, *z* as in *zeal*, *zh* equal to *z* in *azure*, and *y* as in *yoke*. Since these three sounds only differ from the three sounds *s*, *sh*, and *yh* (equals *ch* in *ich*) in being voiced, this second experiment is only appealed to in order to enforce the teaching of the first and convince the student that there are three well-marked positions of the tongue or the palate. Let us call these positions respectively "front," "middle," and "back." So that *s* and *z* are front palatals, *sh* and *zh* are middle palatals, and *y* and *yh* are back palatals.

Having thus established these three positions for continuant palatals, we can now go on to deal with the remaining palatal consonants. The explosive palatals will not occupy us long, for the only examples are *t* and *d* which may be classed with *s* and *z* as front palatals. Of nasal palatals again there are only two good examples, the English *n* and the sound represented by *gn* in French and Italian and by *ñ* in Spanish. Both these sounds are voiced, and may be classified as front and middle palatals respectively. In Icelandic, also, according to Mr. Henry Sweet, the sound represented by *hn* as in *hniga* is a voiceless *n*, so that this may be added to our list.

Finally we come to palatal trills, and under this head we must include *l* and *r*, though in the common English pronunciation of them very little trill is heard. In Scotland and Ireland, however, *r* is always distinctly trilled, and so also is the ordinary Continental *r*. With regard to *l* there is generally audible a very slight trill due to the vibration of the *sides* of the tongue; the point being

fixed against the roof of the mouth. It is this barely perceptible trill which gives to *l* the liquid sound which is so characteristic of this consonant. With *r* on the other hand (*i.e.* the true *r*) the trill is due to the vibration of the *point* of the tongue against the front part of the palate just above the gums. The Cockney *r* is quite a different sound. It is not a trill at all, and is not formed by the the point, but by the body of the tongue, and so far back on the palate as to approach the guttural region. As the writer hears it and pronounces it, this consonant is intermediate between the guttural *gh* (German *tag*) and the back-palatal *y*. We can, therefore, best classify it as a voiced continuant far-back-palatal; while the North-country and Continental *r* is a voiced trilled front-palatal, and *l* is a voiced trilled mid-palatal. We are now in a position to make a little table of palatals, similar to the table of gutturals above. Here it is:—

	Explosives.	Continuants.	Trills.	Nasals.
Far-back	..	Cockney r	...	...
Back	.	yh y	...	..
Mid	..	sh zh	lh l	ñ
Front	t d	s z	true r	hn n

DENTALS.

This table disposes for the present of palatals, and we can now go on to frame a similar table of dentals. This will not take us long, for the purely dental consonants are not numerous. We have already mentioned the *th* in *thin*, and to this we can at once add its counterpart the voiced *dh* represented by *th* in *them*. These two sounds are of course continuants, and in English we find no explosive dentals, for the English *t* and *d* are, as has been already explained, palatals. But the *t* and *d* of most Continental languages are dental, and in Italian almost interdental. To anyone whose ear has been trained, the distinction between the English and the Italian *t* and *d* is quite obvious. And so easily is the distinction made, that in Hindustani both pairs of sounds exist, and convey totally different meanings. For convenience let us denote these soft Italian sounds by (*t*) and (*d*) and our table of dentals will then be as follows:—

	Explosive.	Continuant.
Voiced	(d)	dh
Voiceless	(t)	th

LIP-TEETH.

We now come to a group, or rather a pair, of consonants which might be classified either as dentals or as labials, for they partake of the character of each class. They are the consonants *f* and *v*. As was explained earlier in these lessons, *f* and *v* are pronounced by placing the lower lip in contact with the edge of the upper teeth, and forcing the breath out of the mouth through the chinks that are left. An expressive but clumsy name for these consonants is the one suggested by Mr. Henry Sweet —"lip-teeth."

LABIALS.

Finally we come to labials proper. We have already mentioned the explosives *p* and *b*, and corresponding to these two familiar sounds we have two continuant labials which we may represent by *ph* and *bh*. The second of them is the German *w*, a sound which it is extremely difficult for Englishmen accurately to reproduce. It lies intermediate between the English *v* and the English *w*, and in pronouncing it the lips neither touch the teeth, as in the case of the former letter, nor are the cheeks drawn in as in the case of the latter. The best way to learn to pronounce it is to say *b*, and then try and make this sound continuous. If the student is successful in doing this, he will produce a sound which he will at once recognise as a cross between the English *v* and *w*. This German *w* or *bh* also occurs in Hindustani, and English children brought up by native servants often find much difficulty in learning the rounder English *w*. The corresponding voiceless sound is rarely met with, but in some parts of Greece the letter φ has this pronunciation.

The next consonant we have to deal with is probably the first which we all of us ever pronounced. It is the pure labial *m*. As was pointed out above, the lips are in the same position for *m* as for *b*; the only difference is that in the one case the breath is forced through the nostrils, in the other it is allowed to escape by way of the mouth. The similarity between the two consonants is best brought out in the bleat of a sheep. Half the world thinks a sheep says *maa*, *maa*, and the other half is quite confident that it says *baa*, *baa*. Apparently the Greeks heard neither *b* nor *m*, but *bh*, for in a famous line—

ὁ δ' ἠλίθιος ὥσπερ πρόβατον βῆ βῆ κράζων βαδίζει.
"The fool goes crying βῆ, βῆ, like a sheep."

We see that the letter β is used to represent the consonant heard, and the best accepted theory of ancient Greek pronunciation attributes to this letter the sound of *bh*, represented in German by *w*. The explanation of this difference of opinion is very simple. The essential part of the sheep's cry is the vowel *aa*, *aa*, and very often the sheep commences its cry with its mouth open so that no labial con-

sonant could possibly be heard at all. But when it opens its mouth while beginning its cry, some consonant effect will be heard, but whether this is the explosive labial *b*, or the continuous labial *bh*, or the nasal labial *m*, is naturally not easy to determine—and we are not going to try. For the only object of this little discussion is to convince the student of the similarity of the three consonants *m*, *b*, *bh*, by an illustration of their confusion.

These three are all labials, but we have in our English language two other labial consonants, which stand apart from these. They are *w* and *wh*. Let us first deal with *w*. This is formed by the protrusion of the lips accompanied by a compression of the cheeks. It is, in fact, a consonantal *ōō*. That it *is* a consonant the student must be careful to verify for himself. He will find that he can pronounce *ōō* without any difficulty by itself, and can prolong the sound as much as he chooses. The lips meanwhile are well apart, and the breath issues without audible friction. With *w*, on the other hand, the lips must be brought more nearly together, and a distinct friction of the breath against the lips is audible. Also the student will find it hard to separate the *w* from the vowel following, as, for example, in the word *wo*. Therefore *w* is a consonant. It is a labial, because it is formed by the lips; but it differs from *b* and *bh* because the lips are more protruded. We will therefore call it a front labial. It is a continuant, because the sound is due to the continued friction of the breath against the lips and not to a sudden explosion. Lastly it is voiced, because in pronouncing it the vocal chords vibrate. The consonant *w* is therefore a voiced continuant front-labial. What is *wh*, *i.e.*, the *w* in *which* as pronounced by Irishmen or Scotchmen? It is nothing but the voiceless equivalent of *w*, just as *f* is the voiceless equivalent of *v*. Cockneys for some reason seem to find this sound as troublesome as they find the Welsh *ll*, which, as already explained, is the voiceless equivalent of *l*. Thus, the ordinary Cockney pronounces *when* and *wen* in exactly the same manner. Some people are apt hastily to think that this is part of the general Cockney carelessness about the letter *h*. Nothing of the sort. The consonant *wh* is not a *w* with an *h*, it is a *w* without voice.

And this brings us to the question, what is the letter *h*? It is neither a consonant nor a vowel, it is an aspirate. That is to say, the letter *h* merely represents extra breath employed in the pronunciation of certain sounds. In English we only use this extra breath to accompany the beginning of the sound. Thus, if we take, for example, the vowel *a* in *father*, and if before pronouncing it we make a slight additional effort with the lungs so as to expel some additional breath, we get the sound represented by *ha*. And most of us, it is to be hoped, can distinguish quite easily between these two sounds, *a* and *ha*. But English people are generally at a loss when the *h* is final instead of initial. It is true we habitually write *ah* to represent a certain exclamation, but very few people make any difference in pronouncing this sound and in pronouncing the simple vowel *a* in *father*. In other countries, however, final aspirates are by no means uncommon. In many of the Indian languages, for example, consonants are frequently followed by an aspirate, and the aspirated consonant is immediately distinguished by native ears, or by trained European ears, from the unaspirated.

One word more on the subject of this very important letter *h*. We said above that it was *an* aspirate, not *the* aspirate, and the distinction is an important one, not only from a scientific, but from a practical point of view. From a scientific point of view every vowel is preceded by a breathing, or aspirate, and the particular breathing represented by the letter *h* is only somewhat harder than the ordinary breathing. In our system of spelling we ignore the soft breathing, leaving it to be understood, and only mark the hard breathing. But the Greek grammarians used to mark both; thus ἠ denotes the long *ee* sound preceded by a soft breathing, and in our spelling would be represented merely by *ee*; while ἡ, with the comma turned round, is the Greek way of representing the sound which we spell *he*.

This, however, is not all. Not only is it scientifically accurate to take note of the soft breathing as well as of the hard, but we must also practically recognise the existence of a still harder breathing than our aspirate. In Arabic, for example, one of the most important languages in the world, there are two well-marked aspirates. One, the equivalent of our letter *h*, the other a much deeper and more violent aspirate, which Europeans find great difficulty in imitating.

These remarks about the letter *h*, which could not conveniently be any longer postponed, interrupted us just as we had concluded the enumeration of all the consonants of the English language, and were about to arrange them in a complete table. That is the only task that now remains for us to do before closing this subject. Let us first briefly recapitulate the points at which we had arrived. We had first of all divided all consonants into *voiced* and *voiceless*—the voiced consonants being those in the pronunciation of which the vocal chords of necessity vibrate, as *b*, *d*, *v*; the voiceless those where the vocal chords are silent, as *p*, *t*, *f*. Next,

by a cross-division, we had further classified consonants into (*a*) *explosives*, such as *p*, *d*, where the sound is produced by a sharp expulsion of the breath from the mouth; (*b*) *continuants*, where the breath is allowed gradually to escape, as with *f* and *th*; (*c*) *trills*, where the breath as it escapes is interrupted by the rapid vibration of the tongue, as with the Scotch and Irish *r*, and, to a less extent, with the English *l*; (*d*) *nasals*, where the breath escapes through the nostrils instead of through the mouth, as with *m* and *h*. Finally, we further cross-divided these divisions, and classified the different consonants according to the position of the vocal organ by which they were produced. Thus, we called the consonant *g* a *guttural*, because for its production the tongue must be well back in the mouth towards the throat. For an analogous reason we called *y*, *s*, *l*, *d*, *n*, etc., palatals, because they are produced by contact between the tongue and various parts of the palate. In the same way *th* in *thin*, and *dh* in *then* were called *dentals*, *f*, *v* were called *lip-teeth*, *m*, *b*, and *w* were called *labials*. All we have now to do is to sum up these results as best we can into one concise statement. For convenience in printing it will be better to separate the voiced and the voiceless consonants, and to present the classification we have arrived at in the following two tables:—

VOICED CONSONANTS.

	Explosives.	Continuants	Trills.	Nasals.
Gutturals, Back	—	*Indian* gh	—	—
„ Forward	g	*German* gh	ghr	ng
Palatals, Far-back	—	*Cockney* r	—	—
„ Back	—	y	—	—
„ Mid	—	zh	l	ñ
„ Front	d	z	*Scotch* r	n
Dentals	*Italian* d	dh	—	—
Lip-teeth	—	v	—	—
Labials, Back	b	*German* w	—	m
„ Forward	—	*English* w	—	—

VOICELESS CONSONANTS.

	Explosives.	Continuants	Trills.	Nasals.
Gutturals, Back	*Indian* q	*Indian* kh	—	—
„ Forward	k	*German* ch	—	—
Palatals, Far-back	—	—	—	—
„ Back	—	yh	—	—
„ Mid	—	sh	lh	—
„ Front	t	s	—	hn
Dentals	*Italian* t	th	—	—
Lip-teeth	—	f	—	—
Labials, Back	p	*Greek* φ	—	—
„ Forward	—	wh	—	—

For the explanation of such symbols as *yh* and *zh*, or for any other points on which for want of space these tables are insufficiently explicit, the student must turn back to the previous lessons, where he will find them fully explained.

EXERCISES.

If the student desires to take the fullest advantage of the passages we quote from the works of English authors, he will not only read them aloud, but attempt to write them out afterwards in his own words.

A LETTER.

July 28, 1803.

I am glad to find that you have spent the spring so pleasantly. But when you say you made the excursion instead of coming to London, you forget that you might have passed the latter end of a London winter in town after enjoying the natural spring in the country. We have been spending a week at Richmond, in the delightful shade of Ham walks and Twickenham meadows. I never saw so many flowering limes and weeping willows as in that neighbourhood. They say, you know, that Pope's famous willow was the first in the country; and it seems to corroborate it, that there are so many in the vicinity. Under the shade of the trees we read Southey's "Amadis," which I suppose you are also reading. As all Englishmen are now to turn knights-errant, and fight against the great giant and monster, Buonaparte, the publication seems very reasonable. Pray are you an alarmist? One hardly knows whether to be frightened or diverted on seeing people assembled at a dinner-table, appearing to enjoy extremely the fare and the company, and saying all the while, with a most smiling and placid countenance, that the French are to land in a fortnight, and that London is to be sacked and plundered for three days—and then they talk of going to watering-places. I am sure we do not believe in the danger we pretend to believe in; and I am sure that none of us can even form an idea how we should feel if we were forced to believe it. I wish I could lose, in the quiet walks of literature, all thoughts of the present state of the political horizon. My brother is going to publish "Letters to a Young Lady on English Poetry." He is indefatigable. "I wish you were half as diligent," say you. "Amen!" say I. Love to Eliza and Laura, and thank the former for her note. I shall always be glad to hear from either of them. How delightful must be the soft beatings of a heart entering into the world for the first time, every surrounding object new, fresh, and fair—all smiling within and without! Long may every sweet illusion continue that promotes happiness, and ill befall the rough hand that would destroy them!
—*Mrs. Barbauld.*

SOUTHEY'S SCHOOLING.

Here one year of my life was passed with little profit, and with a good deal of suffering. There could not be a worse school in all respects. Thomas Flower, the master, was a remarkable man, worthy of a better station in life, but utterly unfit for that in which he was placed. His whole delight was in mathematics and astronomy, and he had constructed an orrery upon so large a scale that it filled a room. What a misery it must have been for such a man to teach a set of stupid boys, year after year, the rudiments of arithmetic! And a misery he seemed to feel it. When he came to his desk, even there he was thinking of the stars, and looked as if he were out of humour, not from ill-nature, but because his calculations were interrupted. But, for the most part, he left the school to the care of his son Charley, a person who was always called by that familiar diminutive, and whose consequence you may appreciate accordingly. Writing and arithmetic were all they professed to teach; but twice in the week a Frenchman came from Bristol to instruct in Latin the small number of boys who learnt it, of whom I was one. That sort of ornamental penmanship, which I now fear has wholly gone out of use, was taught there. The father as well as Charley, excelled in it. They could adorn the heading of a rule in arithmetic in a

ciphering-book, or the bottom of a page, not merely with common flourishing, but with an angel, a serpent, a fish, or a pen, formed with an ease and freedom of hand which was to me a great object of admiration; but, unluckily, I was too young to acquire the art. I have seen, in the course of my life, two historical pieces produced in this manner; worthy of remembrance they are, as notable specimens of whimsical dexterity. One was David killing Goliath; it was in a broker's shop at Bristol, and I would have bought it if I could have afforded at that time to expend some ten shillings upon it. They taught the beautiful Italian, or lady's hand, used in the age of our parents; engrossing (which, I suppose, was devised to ensure distinctness and legibility); and some varieties of German text, worthy, for their square, massy, antique forms, to have figured in an antiquarian's title-page.—*Robert Southey.*

CHEMISTRY.—XII.

[*Continued from p 68.*]

IRON — CAST-IRON — WROUGHT-IRON — STEEL — COBALT—NICKEL—GERMAN SILVER.

Iron (Fe), atomic weight 56, specific gravity 7·8. This is one of the most important of metals, it is found occasionally native in meteorites, etc., but its principal ores are the various oxides and the carbonate. *Magnetic Oxide* (Fe_3O_4) occurs in black compact masses in Sweden, America, etc.; it is a very pure iron ore. *Red hæmatite* or *Specular iron ore*, Fe_2O_3, is found in hard rounded masses, or in brilliant black crystals; all varieties when scratched with a file give a red mark, or "streak"; it occurs in the island of Elba, in America, Lancashire, Cumberland, etc. *Brown hæmatite*, $Fe_2O.Fe_2(HO)_6$, is usually found in brown fibrous-looking masses: it occurs in the Forest of Dean, etc.; one variety occurs at the bottom of lakes in Sweden. *Spathose iron ore* or *siderite*, $FeCO_3$, occurs in large quantities in this country, and is our most important iron ore; mixed with sand and clay it forms the "clay iron-stone," when black from the admixture of coal it forms the "black band ironstone."

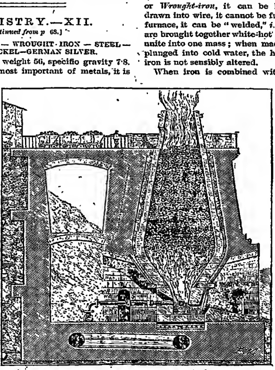


Fig. 39.

The ore is first roasted to convert it into oxide of iron, FeO, and is then smelted in large furnaces, 60 to 100 feet high, termed blast-furnaces; before entering into details of the preparation of iron, it will be necessary to study the enormous differences produced in the properties of iron by the presence of comparatively minute quantities of carbon.

Pure iron free from carbon is termed *Malleable* or *Wrought-iron*, it can be hammered out and drawn into wire, it cannot be fused in any ordinary furnace, it can be "welded," *i.e.*, when two pieces are brought together white-hot and hammered, they unite into one mass; when made red-hot and then plunged into cold water, the hardness of wrought-iron is not sensibly altered.

When iron is combined with about 0·3 to 1·4 per cent. of carbon, we get all the varieties of steel.

A typical *steel* is malleable, ductile, and weldable, it can be easily melted in a good wind furnace; it can be "tempered," *i.e.*, if cooled suddenly it becomes harder than glass, if cooled slowly it is quite soft.

If we increase the quantity of carbon from 1·4 to 5 per cent., we get the various cast- or pig-irons.

Cast - iron is brittle, it is neither malleable nor ductile nor weldable; it is much more easily fused than steel.

The roasted iron ore which contains in addition to the oxide of iron impurities as sand, clay, etc., is thrown into the blast-furnace in truckloads with

limestone ($CaCO_3$) and coal. The blast-furnace is a huge circular brick furnace, 50 to 100 feet high (Fig. 39), lined internally with firebricks, and supported externally with strong iron plates. The lowest part of the furnace is termed the "boshes," D; just below the boshes the furnace contracts considerably, forming the hearth FG. At the bottom of the furnace three large blowpipes or "twyers," T, are inserted, and through these an enormous blast of air, heated to a temperature of 330° Cent., is forced by blowing-fans. The furnace is started by gently heating with a fire of wood a small charge of coal, ore and limestone is then introduced in alternate layers, and the blast turned on; fresh coal, etc., is added until the furnace is in full working order, when it continues working uninterruptedly day and night for months at a time. As the blast of air enters the furnace it combines with the heated carbon, forming carbon dioxide, CO_2; as this proceeds upwards it meets with an excess of intensely heated carbon, and is converted into carbon monoxide, CO; this coming into contact with the oxide of iron, reduces it to the metallic state, $FeO + CO = Fe + CO_2$. We will now trace this iron on its way down. When first reduced it doubtless exists as a spongy mass of wrought-iron, but as it comes into contact with the intensely heated carbon in the lower part of the furnace it combines with the carbon, forming cast-iron, which melts and sinks to the bottom of the hearth. The impurities which accompany the iron ore, sand, clay, etc., would not fuse by themselves, the limestone is therefore added, and with the impurities forms a melted glass or "slag," which sinks to the lower part of the furnace and floats on the melted iron. A body which thus causes an impurity to melt and form a fused slag is called a "flux." As

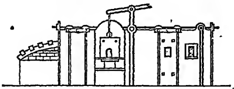


Fig. 40.

the slag accumulates its level rises, and at last it flows out by a hole made for the purpose; the iron is drawn off from time to time by a hole, which is closed when not in use by a plug of clay. The melted iron is cast into bars in sand moulds, forming the "pig-iron" of commerce. The colour of the fractured surface of cast-iron varies according to the quantity of carbon it contains, and the rate at which it is cooled; thus we have "white pig," "grey pig," and various "mottled pigs;" the grey colour is believed to be due to particles of graphite which separate out; in the white pig the whole of the carbon is believed to be combined chemically with the iron.

The next step is to convert the cast-iron or pig-iron into *malleable or wrought-iron*. This is effected in a puddling furnace about 5 feet high, in which the flame is reflected or reverberated from the roof

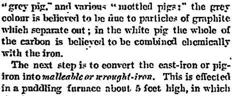


Fig. 41.

of the furnace on to the melted pig-iron placed on the hearth. This reverberatory furnace is shown in Fig. 40, and a section in Fig. 41. The cast-iron is melted, and the puddler adjusts the draught of the furnace so that it contains some oxygen, and then stirs up and splashes the metal with a long iron bar; the iron is oxidised on the surface to oxide, which is mixed by the splashing with the rest of the cast-iron; the carbon combines with the oxygen from the oxide and forms carbon monoxide, which burns in jets of blue flame on the surface of the melted metal. As the carbon burns away, the iron becomes infusible, and the puddler scrapes these pasty particles together until he forms a large mass or "bloom" of white-hot pasty wrought-iron. This is tumbled out into a little iron waggon, which carries off the mass to the steam hammer, where it is beaten into a bar of red-hot iron, and this while still hot is rolled into sheets, drawn into wire, etc. The puddling operation is continued until another bloom is formed, and so on until the whole of the charge is worked off. In the puddling furnace not only is the carbon removed, but the bulk of the sulphur and phosphorus is eliminated at the same time. The presence of these two impurities, especially phosphorus, would be very injurious to wrought-iron. The phosphide of iron partly drains off when the bloom stands up in the bath of melted metal, and is partly squeezed out by the steam hammer.

Steel was formerly made from wrought-iron by a process termed "cementation"; bars of wrought-

iron were stacked up in a furnace with layers of charcoal powder between the bars, the whole then heated in a close furnace to a bright red heat from seven to ten days. During this time, although the iron never melted, the carbon gradually worked its way into and combined with the iron, so at the end of the time the iron was converted into steel; the outside of the bar was usually covered with broken blisters, and the product was therefore termed "blister steel"; it was not uniform in its composition, as the outside of the bar contained more carbon than the inside. To remedy this defect the blister steel was melted, when the carbon was equally diffused, and the product was termed "cast-steel." But in 1856 Bessemer introduced a process of making steel of fair quality direct from cast-iron. *Bessemer steel* is manufactured as follows:—

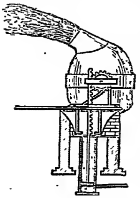


Fig. 42.

The cast-iron is melted and run into a special furnace termed a "converter" (Figs. 42 and 43); this consists of an egg-shaped vessel of firebrick bound with iron, with a short chimney, lined internally with powdered flints or silica. The converter is mounted on a strong axis, so that it can be tipped by hydraulic power into any position; at the bottom of the converter a blast of air is introduced, this is blown through the melted cast-iron, and in 6 to 8 minutes the whole of the carbon from 5 to 12 tons of cast-iron is burnt off and a melted mass of wrought-iron obtained; the blast is stopped and a definite quantity of pure cast-iron containing manganese (ferromanganese) added; the cast-iron melts and furnishes just enough carbon to convert the whole mass into steel, which is then poured off: so that in about 20 minutes 10 tons of cast-iron can be converted into steel. Unless manganese is added, the Bessemer steel is apt to be brittle and unworkable. The great objection to the process, as first carried out, was that all the impurities, phosphorus, sulphur, etc., in the cast-iron passed into the steel, thus only pure varieties of cast-iron could be used. In 1878 Thomas and Gilchrist proposed to line the converter with a base, lime, instead of an acid oxide, silica, and by this simple modification most of the phosphorus is kept out of the steel and combines with the lime which forms the lining of the converter, and thus nearly all varieties of cast-iron can be used for making Bessemer steel. By the Bessemer process steel can be made at about one-eighth of the cost of the old cementation process: the steel is not of such a high quality, but the lowering of the price has enabled it to be used for rails, boats, bridges, etc., and has in fact revolutionised the iron and steel industries. Pure iron is a whitish metal which does not oxidise in dry air, but if moisture be present it is rapidly converted into rust or ferric oxide, Fe_2O_3. Iron is protected by coating it with paint, blacklead, tin, zinc, etc. Iron is easily soluble in dilute hydrochloric, sulphuric, and nitric acids, but is not attacked by strong nitric acid. Cast-iron dissolves but little in strong sulphuric acid. All varieties of iron are magnetic, *i.e.*, they are attracted by a magnet. Permanent magnets can only be made of hard steel. Iron forms three principal oxides, ferrous oxide or protoxide (FeO), ferric oxide or sesquioxide of iron (Fe_2O_3), and magnetic oxide (Fe_3O_4).

When ferrous oxide, FeO, is dissolved in acids, it forms the ferrous salts, which are usually pale green; their solutions have a great tendency to absorb oxygen from the air and pass into the corresponding ferric salts; this conversion can be rapidly effected by boiling with any oxidising agent as nitric acid, by passing chlorine gas, etc. Ferric oxide, Fe_2O_3, when boiled with acids forms

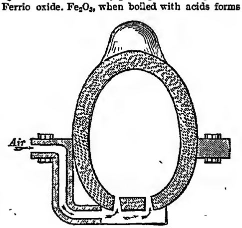


Fig. 43.

the ferric salts, which are mostly brown, or they can be formed from the ferrous salts as mentioned above. Ferric salts can be converted into ferrous salts by reducing agents, hydrogen sulphide, sulphurous acid, nascent hydrogen (zinc and dilute acid), etc.

The magnetic oxide, Fe_3O_4, is formed when steam is passed over red-hot iron; it is deposited as a black, hard, lustrous coating, which has been used by Barff as a protection against the rusting of iron.

The two most important salts of iron are ferrous sulphate and ferric chloride.

Ferrous Sulphate, green vitriol ($FeSO_4 + 7H_2O$). This is prepared by exposing heaps of iron pyrites to the air—

$$FeS_2 + 7O + H_2O = FeSO_4 + H_2SO_4.$$

The oxidised mass is extracted with water, and the ferrous sulphate crystallised out by evaporation; it is used in the preparation of black dyes, ink, Prussian blue, Nordhausen sulphuric acid, etc.; it occurs in hard pale green crystals.

Ferric Chloride, Perchloride of Iron ($FeCl_3$). Iron is dissolved in dilute hydrochloric acid when a solution of ferrous chloride, $FeCl_2$, is obtained; by passing chlorine it is converted into ferric chloride, the solution is then evaporated to dryness and the ferric chloride obtained as a yellowish-brown cake. It is much used in medicine.

Ammonium hydrate and ammonium chloride when added to solutions of ferrous salts give a greenish precipitate which turns rapidly brown on the surface; with ferric salts a rusty brown precipitate is obtained. Potassium ferrocyanide, $K_4FeC_6N_6$, gives with acid solutions of ferrous salts a light blue precipitate, with ferric salts a dark blue precipitate (Prussian blue). Potassium ferricyanide gives with ferrous salts a dark blue precipitate, with ferric salts a brown or green colour. Potassium sulphocyanide gives with ferrous salts (if absolutely free from ferric) no reaction, with ferric salts an intense dark blood-red colour. All these coloured precipitates are destroyed by potassium or sodium hydrate.

A small quantity of an iron salt fused into a bead of borax, which is most conveniently held in

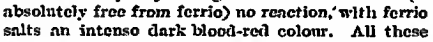


Fig. 44.

a small loop of platinum wire (*see* Fig. 44), gives a yellow colour in the oxidising and a bottle-green colour in the reducing flame of the blowpipe.

COBALT AND NICKEL.

In many respects these metals resemble iron: they are feebly magnetic, their atomic weights are identical, they are whitish metals fusible with great difficulty; they form, like iron, two principal oxides, they usually occur together combined with arsenic and sulphur. Nickel has been found as a silicate of nickel and magnesium, which contains no cobalt. The salts of cobalt are mostly pink or blue, those of nickel green. Nickel occurs in meteoric iron.

Cobalt (Co), atomic weight 59, specific gravity 8·6. The metal is obtained by heating the oxide, CoO, in a current of hydrogen, or by heating the oxalate, CoC_2O_4. In appearance it resembles iron, it is hard, malleable, and tough, readily soluble in dilute hydrochloric, sulphuric, and nitric acids. It has quite recently been used for plating iron, steel, etc. It forms cobaltous and cobaltic salts.

The most common salt is cobaltous nitrate, $Co(NO_3)_2$; it is obtained in pinkish-red deliquescent crystals by dissolving the oxide or carbonate in dilute nitric acid, and evaporating the solution. If the crystals be heated, they leave a blue residue of the anhydrous salt.

A solution of cobalt nitrate has been used as a secret or "sympathetic" ink, the writing when dry being a pale pink; this when held to the fire turns blue, it fades again as it cools and absorbs moisture from the air. The same property is utilised in the flowers, paintings, etc., which turn blue when the atmosphere is dry, and pink as rain approaches.

Cobalt salts give no precipitate with ammonium hydrate and ammonium chloride, but give a black precipitate with ammonium sulphide.

If a minute portion of a cobalt salt be fused into a borax bead, the latter is coloured blue.

Nickel (Ni), atomic weight 59, specific gravity 8·9. This is a yellowish-white metal; it is malleable and weldable, it dissolves easily in dilute nitric acid, but somewhat slowly in hydrochloric and sulphuric acids. It is prepared by heating the oxide with charcoal powder to a very high temperature.

Nickel is much used for the white alloy known as "German silver," "nickel silver," etc.; it is a mixture of brass (2 copper, 1 zinc) with 10 to 20 per cent. of nickel. Of late years nickel has been extensively used for plating brass, iron, steel, etc. The deposit of pure nickel is very hard, nearly white, and is not tarnished by sulphur compounds. It is usually deposited from a solution of the double sulphate of nickel and ammonium by the aid of electricity. The compounds of nickel are mostly green. Nickel combines with carbon monoxide, forming a colourless volatile liquid, $Ni(CO)_4$. The most important salt is the sulphate, $NiSO_4 + 6H_2O$; it is obtained in hard green crystals by dissolving the metal, oxide, or carbonate in dilute sulphuric acid, and evaporating the solution. Solutions of nickel give no precipitate with ammonium hydrate and ammonium chloride, but a black precipitate is produced by ammonium sulphide. The borax bead is smoke-coloured when a little nickel is present, but becomes sherry-red when more nickel is added.

LATIN.—XXVII.

[Continued from p. 72.]

ORATORICAL PROSE (continued).

§ 44. In translating the following speech into Latin, we should aim especially at simplicity, directness, and concrete expressions. A large use of asyndeton will represent the impassioned excitement which pervades the original:—

Do you suppose, gentlemen of the jury, that I am inventing a fact which is evident to all, known and remembered by everyone, that he was intending to enroll an army of the dregs of the population in this very capital, by means of which to possess himself of the control of affairs and of the property of us all? If so, supposing his assassin, holding in his hands the blood-stained sword, cried out:—"Come round and listen, fellow-citizens! I have killed the hated demagogue. With this sword and with this right hand of mine, I have struck from your necks the yoke of his excesses, which we could no longer curb by law or legal processes. I wished by my own unaided efforts to preserve for my country law and equity and constitutional liberty, modesty and chastity."—I say, in such a case there would be reason to fear the temper in which the country would take it! But, as it is, there is no one who would not approve and praise the deed, and say, ay, and think it too, that he has conferred greater benefits upon the State, and has given the people of London and all England, and even the whole world, greater cause for rejoicing than anyone else in the memory of man. It is not in my power to estimate the intensity of the transports of joy which the English people experienced in former times; but in our own day we have seen many glorious victories won by generals of the highest rank, and no one of them all has brought us such an intense and lasting feeling of joy as this.

§ 45. Philosophical Prose.

We need not dwell long on the prose-style known by the name of "philosophical." Most of our own essayists write in such a style. A rather elaborate conversational manner, easy and fluent, with comparatively little use of the lengthened period (at least, much less than in historical prose), and free use of the chief oratorical figures (especially of interrogation)—these are its chief characteristics. In literary form it is nearest akin to Oratory and conversation (especially as the dialogue-form was so much employed), and farthest removed from the historical style. We shall best secure the style required by aiming at such a mean as that we have described; and in order to estimate it rightly, we must briefly note the characteristics of the epistolary style.

§ 46. Epistolary Prose.

The first thing that strikes us in reading Latin letters is the absence of the period. We have seen that it can have no place in conversation; and in the epistolary style most of the characteristics of conversation are preserved. The sentences are short, the order (to our ideas) much more natural, the style generally much more careless. Having accustomed ourselves to the elaborate artificial structure of historical prose, we are now introduced to a style so completely different, that we feel the Romans had practically two languages, one for writing and one for speaking, one for literary purposes and one for ordinary use in daily life.

No sketch of Latin Prose—and what we are able to set forth in these few pages can only be a sketch—would be complete, or give a true impression of its subject, that did not recognise this fact. It is only in some styles of Literary Prose, the Historical and Oratorical, that we find a consistent employment of the elaborate rules of order of words and clauses that we have dwelt upon, and only in the Historical style do we find a full use of the most characteristic of all Latin literary inventions—the Period. In ordinary conversation, and in letters to their friends, the Romans allowed themselves much greater liberty of order, and were much simpler in building up their sentences.

Accordingly, in rendering letters in English into Latin, we shall do well to follow the English order and structure much more closely than is permissible in the other styles of prose composition.

There are, of course, besides these general characteristics, some special phrases and idioms to note, the most important of which are the following:—

(i.) The address and date are not placed at the beginning of the letter as in English. Often both are entirely omitted. If described at all, they are usually found abbreviated at the end of the letter —*e.g.*, *Idibus Jun. ex castris*, *Dat. a. d. iv. Kal. Novembr.*, *pridie Kalendas Maias Brundisio.*

(ii.) The letter does not begin "My dear ——," though the equivalent phrase in the vocative (*e.g.*, *mi Brute*, "my dear Brutus") is commonly used parenthetically in the course of the letter. Nor does it end, as do ours, with an affectionate farewell and signature. Latin combines our beginning and end in a formal superscription, *e.g.*, Q. Cicero S.P.D. Tironi Suo, where S.P.D.

stands for *salutem plurimam dicit* ("greets most affectionately his dear T.," "sends his best love"), S.D., or S. alone, may also be used. But there is also often found at the end the imperative *Vale*, and such phrases as *multum te amamus, cura ut valeas, ama nos et vale, bene vale et Tironem meum saluta nostis verbis* ("give my love to"), or *valere X. jubebis litteris.*

(iii.) Allusions to the posting and delivery of letters must, of course, be in accord with Roman customs and postal arrangements; and it must be remembered that there was no post, in our sense of the word, organised by the State. Letters were sent by friends who might chance to be travelling in the direction required, or by slaves who were kept for the purpose. So, "To send (*or* write) a letter by the post to anyone," is *Dare litteras tabellario ad aliquem*; to "deliver" it, is *perferre.*

(iv.) We have noted the precision of Latin in its use of *scribere* for our "say," "tell," in letters. Another idiom, due to the same cause, is the use of the *imperfect tense* for the present when the time of writing is alluded to: the writer projecting himself into the time at which the letter would be read by his correspondent, and using the tense which would then be exact. *Ellipses* are, of course, much more common than in the more elaborate styles of prose-writing.

With these hints, we may conclude our course with a few practical experiments in letter-writing in Latin.

§ 47.

(1.) India, 27th June.

My dear Arthur,

Although I have absolutely no news of anything that has happened since I posted a letter to you; yet, as the mail is leaving for London, I ought to send you a line. And first of all, a point which is worrying me more than anything else—not, however, that you can give me any help in it; for the matter is staring me in the face, and you are far away. On the 30th of August I must resign my governorship. Whom am I to leave behind in charge of the government? Sound sense and public opinion say my brother. But, in the first place, there's this about him—I don't think he could be induced to undertake it, for he hates the position, and it's true there's nothing more invidious and burdensome . . . . So, as you see, I'm in distraction, and greatly in need of advice. In a word, I ought to have had nothing to do with the whole business . . . *Entre nous*, I have not received a single letter from X. which has not contained some piece of arrogance. However, he rouses my laughter more than my anger; but it is quite clear he doesn't give a thought to what he is writing, or to whom. My brother's son read a letter addressed to his father (he commonly opens them by my directions, in case there should be anything which ought to be known), and in that letter there was the same remark about his sister which was in mine. I saw the lad was wonderfully disturbed. He complained of it to me, with tears in his eyes. To be brief, I recognised that he is of a wonderfully affectionate, sweet, and kindly disposition. I wanted you to know that, . . . There's one more thing. I should be obliged to you if you would send me W.'s speech against the Land Bill. Do write to me as soon as possible; if necessary, by a special messenger. Give my love to your admirable wife and daughter. Take care of your health. With love and all good wishes, Believe me, ever yours,

A. W. D.

(2.) Brindisi, 8th April.

Dear Tom,

I received several letters from you by the same post, which you sent at different times. You may be sure that the business you mention is as near to my heart as to yours . . . . But to return to your letters—everything else is excellent, but one thing surprises me. No one but yourself—that is, no one who writes his own letters—sends several copies of the same letter. As for its being on the back of an old MS., well, I commend your frugal mind. But I do wonder what there was on that piece of paper which you choose to erase rather than not write this, unless, indeed, it might be your own speeches . . . . Or do you mean to imply that there is nothing doing, that you are at a discount, and that you haven't even enough paper? If so, it's your own fault, for carrying your modesty off with you instead of leaving it behind with me . . . . Don't be surprised if a rather long time elapses between my letters; I am to be away in May. Take care of yourself, and remember me to Brown. Mary sends her love. Yours affectionately,

A. J.

P.S.—I have destroyed the letter that Russell has sent me from you, harmless though it was, for there was nothing in it that anyone might not have read. Bot Russell said it was your request, and you too wrote so upon it. But let that be. I'm much surprised that you haven't written to me since, especially as things have changed so.

With these letters we must bring our course of Latin Prose to an end.

We cannot hope that the student who has gone through it will have perfectly acquired the art of writing Latin. It is not to be learnt so readily. But he will, at all events, have gained much insight

into the structure of the language, and some skill and experience in practically applying the principles on which it was built up by the greatest of the Latin writers.

Above all, he will—if he has followed out for himself the lines on which these lessons have been laid before him—have found material for his own thought. He will realise, perhaps, a little more vividly than before some of the problems language suggests—some of the lessons it has to teach us. His observation, intelligence, and power of logical discrimination must have been quickened. Composition in such a language as Latin must at least develop that most precious of all intellectual faculties, the power of penetrating through the form (the outer veil), and seizing on the idea itself (the inner thought).

KEY TO TRANSLATION FROM VERGIL.—II.

And now they were mounting a slope, which in its great extent hangs over the city and looks down on the towers that face it. Æneas wonders at the mighty work where huts once were; he wonders at the gates of the city, the din (of men), and the smooth streets. The Tyrians glow with their task; some mark the walls and toil at the citadel, and roll up boulders with their hands; some choose a place for the building, and mark it out with a furrow; they appoint laws and magistrates and the reverend senate. Such is the toil that in the early summer tasks the bees in the sunshine over the flowery meads, as they bring out the grown-up offspring of the race, or as they distil the clear honey, and fill full the cells with sweet nectar; or receive the burdens of the incomers, or forming a band, keep off the lazy herd of drones from the hives. The work glows, and the fragrant honey is redolent of thyme. "Blessed are ye, whose walls are already rising!" says Æneas, and looks up at the towering heights of the city.

. . . .

Here Dido, of Sidonian race, was founding a mighty temple to Juno, rich in the gifts bestowed on it and in the favour of the goddess. Here first within the grove a strange sight met (Æneas) and soothed his fear; here first Æneas dared to hope for safety, and to put a better trust in his shattered fortunes. For while, as he waited (the coming of) the queen, he looks at each thing beneath the mighty temple's roof; while he wonders what fortune the city has, he sees the Trojan fights (set out) in due order, and the wars, the fame of which is now spread over the whole world; the sons of Atreus, and Priam and Achilles wroth with each. He stood still, and weeping, says, "What spot is there now, Achates—what quarter in the earth's (wide) lands that is not full of our travail! See Priam here! Here, too, glory has the reward that is its due; tears belong to (human) things, and the fates of mortals touch men's minds. Quit thy fears; this fame of ours will bring to thee some safety." So he speaks, and his soul broods on the empty picture.

KEY TO EXERCISES.

p. 68.

Te invito, scribentem eum occupavi. Nos aptos vinculis oneraverunt. His dictis abiit. Eos adhuc cenantes oppressit. Scribenti mihi occurrit nuntius. Quo responso manere statuimus. Turba faventium eos sequente ex urbe discedunt. Nunquam in integrum restitui debent damnati. Nomina civitate donatorum in tabulis incisa sunt. Veluti flammas spirantium miraculo attoniti constiterunt. Haec praecepit Trajanus moriens. Jam etiam extollere adversarium volunt pauci. Paupertas nascentes eos circumstetit. Haec omnia invictum Romanum imperium praestant. Dictator Romae creatus etiam hostibus metum incussit. Amicos etiam inimicos dilige. Levitatem tamen assentientium senatus. Ad castra progredienti mihi illud dicebant. Jam hostes se errare intellexit. Diadema abjectum rursus sustulit. Non nisi punito illi persuasum erit. Fremitus indignantium per totam curiam audiebantur. Illum sequens nunquam errabis. Patrem verita tantum facinus est ausa. Consule omnino alia censente pugnam iniit. Nullo praemio proposito, nullo amico adjuvante, vicit. Re omnino infecta sperabat fore ut laudaretur. Praedonibus oppressis urbem ovans intravit. Caesorum clade Variana reliquias uno tumulo humavit. Insanientis est hoc existimare. Saepe victi salute desperata manus dant. Mihi quae adesset interroganti nihil respondit.

Fit obviam Clodio ante villam ejus, hora fere undecima aut non multo secus. Statim complures cum gladiis in hunc faciunt de loco superiore impetum: adversi rhedarium occidunt. Cum autem hic de rheda, rejecta paenula, desiluisset acque acri animo defenderet, illi, qui cum Clodio erant, gladiis eductis, partim recurrere ad rhedam, ut a tergo Milonem adorirentur, partim, quod hunc jam interfectum putarent, ejus servos, qui post erant, caedere incipiunt: ex quibus, qui animo fideli in dominum et praesenti fuerunt, partim occisi sunt, partim, cum ad rhedam pugnari viderent, domino succurrere prohiberentur, Milonem occisum et ex ipso Clodio audirent et re vera putarent, fecerunt id servi Milonis (dicam enim non derivandi criminis causa, sed ut factum est), neque imperante neque sciente neque praesente domino, quod suos quisque servos in tali re facere voluisset.

p. 69.

Utrimque clamore sublato, excipit rursus ex vallo atque omnibus munitionibus clamor. Nostri, emissis pilis, gladiis rem gerunt. Repente post tergum equitatus cernitur: cohortes aliae simul appropinquant: hostes terga vertunt; fugientibus equites occurrunt: fit magna caedes. Ludovicus, dux et princeps Lemovicum, occiditur: Arvernorum princeps vivus in fuga comprehenditur: signa militaria fere quinquaginta ad Caesarem referuntur: pauci ex tanto numero se incolumes in castra recipiunt. Interea socii ex oppido conspicati caedem et fugam suorum, desperata salute, copias a munitionibus reducunt. Fit protinus, hac re audita, ex castris Gallorum fuga. Quod nisi crebris subsidiis ac totius diei labore milites essent defessi, omnes hostium copiae deleri potuissent. Missus tamen de media nocte equitatus novissimum agmen consequitur. Magnus numerus captus interficitur, reliqui ex fuga in pagos discedunt.

p. 70.

Quod si non tuis nefariis in hunc ordinem contumeliis in perpetuum tibi curiam praeclusisses, quid tandem a te tantum erat actum aut gestum, de quo ad senatum cum gratulatione aliqua scribi abs te oporteret? Vexatio Macedoniae? an oppidorum turpis amissio? an agrorum depopulatio? an exercitus nostri interitus ferro, fame, pestilentia? Tu vero, qui ad senatum nihil scripseris, ut urbe nequior inventus es, quam Gabinius, sic in provincia paullo tamen quam ille demissior. Nam ille gurges atque heluo, natus abdomini suo, non laudi atque gloriae, cum equites Romanos in provincia fortunis fama privasset cum egisset aliud nihil in illo exercitu, nisi ut urbes depopularetur, agros vastaret, exhauriret domos, ausus est (quid enim ille non auderet?) a senatu supplicationem per litteras postulare. O dii immortales! tunc etiam, atque adeo vos, geminae voragines scopulique reipublicae, vos meam fortunam deprimitis?

vestram extollitis? cum de me absente sint eae contiones habitae, ea senatus consulta facta; ea municipiorum decreta, ea publicanorum, ea collegiorum, ea denique generum ordinumque omnium, quae ego non modo optare nunquam auderem, sed cogitare non possem: vos autem sempiternas foedissimae turpitudinis notas subieritis?

HISTORIC SKETCHES, GENERAL.—VII.

[*Continued from p. 76*].

THE THIRTY YEARS' WAR.

THIRTY years of war! Thirty years of battle, murder, and sudden death; thirty years of anarchy and destruction; thirty years in which two strenuously opposed hosts did their utmost to mar so much of God's image in one another as thirty such years left remaining in them. Why all this bloodshed? The conquerors and the conquered called themselves Christians, professed to be guided by the teaching of Him who bade His follower put up his sword into its sheath, and ordered the smitten on one cheek to turn the other cheek also to the smiter. It is true that He said so, true also that He warned His followers that He was come not to bring peace upon the earth but a sword—that is to say, that though He Himself taught His disciples, by His own precept and example, not to resist evil, He knew that what He taught would so divide men as for a time, and even, perhaps, at recurring times, to put the sword of strife between them. The parents were to be divided against their children, the wife against her husband; and a man's foes were to be they of his own household.

This state of things had been seen in Christendom on more than one occasion, but not accompanied by any great convulsion. It had been rather local than general, showing itself in the form of heresies with their attendant persecutions, rather than in any universal outbreak. In early days the circumstances of the Christian Church were such, that union amongst its members was indispensable to its existence, surrounded as it was on all sides with implacable foes, and overlooked from its midst by an irresistible pagan master, who looked contemptuously on its practices, and derided its principles as unmanly. When, in the course of time, the Christian Gospel made its splendid but bloodless victories, and the master who, erewhile oppressed, became its champion and supporter, while all the nations of Europe heard its message gladly, the Church was too much occupied in consolidating its power, the people were too ignorant in the newness of their conversion, for any serious disturbances to take place. Occasionally, indeed, as time grew older, and corruptions which had crept in began to be seen and spoken about, there was agitation and trouble, as when John Huss raised his voice in Bohemia against spiritual wrong-doing, and having brought down the wrath of ignorant rulers upon him, perished a witness for truth; as when John Wyclif, in our own country, undertook to withstand the traditions of the elders where those conflicted with the revelations written for man's instruction in God's Bible; as when Savonarola, in 1497, preached to the people of Florence, and was, for their sins or his own, put to death in the market-place.

But it was not till the year 1517, when Martin Luther trod under foot and burned the Pope's Bull at Wittenberg, that Christendom saw the fulfilment, on a large scale, of the words which the Redeemer had addressed to His apostles. In the flame that burned the Papal Bull to ashes was kindled the scorching fire of a so-called religious war, which raged furiously for the space of thirty years, involved nearly every European nation in its toils, and at its finish left Europe purified, though exhausted; purged from many sins and many follies which perhaps actually required so great a remedy for their removal.

The Thirty Years' War was in effect the war between Roman Catholicism and Protestantism, between the old order which was changing, and the new which forced change upon it. It sprang from a number of causes, but the immediate outburst was on this wise.

Since the Reformation till the year 1612, the German Protestants had enjoyed the free exercise of their religion. Their numbers and the importance of their leaders, including as they did some of the more powerful among the lesser princes, had won this for them, and they lived peaceably enough with their Roman Catholic countrymen. The rights of the Protestants were under the protection of the Emperor, as head of the Empire. All went smoothly enough, in spite of the efforts of the men of the older Church, till the advent of Rudolph II. to the throne. He neglected many of his duties for pleasures harmless enough in themselves, such as clock-making, chemistry and mechanics, but not only useless but pernicious in a king. Whatever statesmanship he had in him led him to join the princes of the Empire in a league against the Turks, who were at that time threatening seriously the western nations of Europe. The Jesuits, who abounded at his court, managed to work the Emperor's organisation to their own ends, and the Protestants getting wind of this, banded themselves together into what they called "The Evangelical Union," at the head of which they placed the Elector Palatine of the Rhine, son-in-law to James I. of England. When

Rudolph died, in 1612, the election fell, to the great horror of the Protestants, upon Matthias, the approved pupil and close ally of the Jesuits and extremists in the Roman Church.

Matthias wilfully failed to protect his Protestant subjects in the enjoyment of their simple right to worship God according to the dictates of their own consciences; the Romanists understood that a nod was as good as a wink from an Emperor whose eyes were intentionally fast shut, and the result was that the Protestants of Germany were evil intreated in many places. Churches in which the Protestants worshipped were pulled down, and a large amount of social persecution went on, though, as yet, the law professed to protect equally all who were under it. Then the League arose, a combination was formed of Roman Catholic princes throughout Europe, not in Germany only, of which the avowed object was to root out the hated Protestant faith wherever it might be. The League had the special blessing of the Pope, and included among its members many of the most powerful persons in Christendom, lay princes as well as ecclesiastical dignitaries; it was rich in wealth and influence, and in bitter hatred for all who were opposed to it.

THE ASSASSINATION OF WALLENSTEIN.

When the Bohemian nobles complained to the Imperial Council at Prague that their churches had been pulled down, and their rites and those who administered them had been insulted, their complaints were received with so much contempt and so little consideration, that the heady Bohemians treated the matter as a personal affront to themselves, hot words followed, and some of the contemptuous councillors got thrown out of window for their pains. To make the situation more difficult, Matthias procured that his cousin Ferdinand, a bigot of bigots on the Roman side, should be King of Bohemia, and his acts and government speedily drove his subjects into revolt. Anarchy was prevailing, civil war was going on in Bohemia, when the Emperor died (1619), and to the distress of the whole Protestant party, Ferdinand was chosen to succeed him. The Bohemians elected Count Frederick, Elector Palatine of the Rhine, to be their king, as he was also head of the "Evangelical Union," and in an evil hour for him he accepted the dignity. The Thirty Years' War now began in earnest.

Frederick's dominions were quickly invaded by a host of Imperialists, whom he was quite unable to withstand; and, unassisted by those from whom he had every natural right to expect help, the unfortunate elector had to put up not only with the loss of Bohemia, but of the Rhenish Palatinate also, a province which was his by hereditary descent.

Shocked but not stunned by this blow, the Protestants of Germany saw that they must at once make a stand, or be for ever kept under the yoke. A new union was formed, and King Christian

of Denmark was placed at the head of it. Under him were the Dukes of Mecklenburg, Count Mansfeldt, an able commander though an adventurer, the Marquis of Brandenburg, and some of the lesser princes on the western side of the Empire. War burst forth instantly. The Danish king was all unready to embark in such a war, and those who relied upon him for leadership and for material help as well, were unable to bring much to the advancement of the cause, except themselves, their swords, and their enthusiasm. On the Imperial side were wealth, the best soldiers in Europe, leaders of consummate ability, and with a belief in the righteousness of their cause which was worth half an army to them. Counts Tilly and Wallenstein—the latter was in the course of this campaign made Duke of Friedland—commanded for the Emperor, and against their skill and the discipline of the troops all Mansfeldt's bravery was in vain. The Protestant provinces were overrun, fire and sword laid waste the whole of that part of the Empire, King Christian was beaten again and again, and finally made peace with the Emperor on condition of renouncing for ever all right to interfere in the affairs of Germany, and of leaving his allies in the war to their fate. The Dukes of Mecklenburg were dispossessed, Wallenstein obtained a grant of the duchies for himself, and the Protestant cause in 1629 looked black indeed.

Help came from a very unexpected quarter. Louis XIII. of France came to the throne a minor, and Cardinal Richelieu was appointed to govern in his name. The Cardinal had two grand ideas of State policy: one was to humble the nobility of France to a minimum of power, so that the king might be all in all in his kingdom; the other was not to allow any foreign State to become so powerful as to make it impossible or even dangerous for France to cope with it. With his home policy, which he carried out bloodily and mercilessly, we have not now any concern, but his foreign policy led him to see, in what was going on in Germany, the certainty of Austria becoming, if not checked, an overmatch for any other European nation whatever. The Cardinal disliked heretics, not so much as such, but because they were necessarily troublesome people to the Government. In France, he crushed the Huguenots with a relentless hand, but he did not object to Huguenots in other people's dominions, especially if, as in the present case, they helped on his policy. If he hated Protestants at all, he hated the Imperial power still more, and he did not scruple to employ and to support the former when they promised to come in conflict with the latter.

A decree of the Emperor Ferdinand published in 1630, and requiring the Protestants to give up all church property of any kind in their use or possession, was entrusted to Wallenstein to carry out, and that despot did his work so cruelly and shamefully that even the Roman Catholics cried out. The deadly rage of the Protestants was once more excited, and, fed by the agents of Richelieu, looked for the "still strong man" with "heart, head, hand," who should concentrate their anger, and then discharge it upon the Imperialists.

Such a man was Gustavus Adolphus, King of Sweden, the most important, both for position and resources, among all the Protestant princes of Europe. When asked to take the place to which Christian of Denmark had shown himself unequal, and from which many a bold man might have shrunk, he hesitated; but having accepted the post, he knew no shirking or shrinking from the work. He devoted himself and all his resources to the undertaking, and having captured the important island of Rügen, landed in Pomerania, June 24th, 1630.

Jealousy kept asunder those who should have hurried to meet him. The Saxon princes even refused him permission to march his army through their territories—a foolish, even criminal act, which caused the strong city of Magdeburg to fall into the hands of Count Tilly, who knew not the meaning of the word mercy, but caused 30,000 of the inhabitants to perish miserably, and the entire city, excepting the cathedral, to be razed to the ground. This awful cruelty of the Imperialists taught German Protestants what they had to expect, and the immediate result was to bind the wavering Protestant princes in a firm bond with Gustavus. The rulers of Pomerania, Brandenburg (now the kingdom of Prussia), Hesse, and after some delay, Saxony, united to support the King of Sweden, who brought men and ability to fight their battles. At Wittenburg they joined their armies with his, and at Leipzig, on the 7th of September, 1631, battle was joined with the Imperial army under Count Tilly, who was defeated with tremendous loss. The ghosts of Magdeburg sat heavily on his sword, and diverted his talents from their usual successful channel. His valour and his counsel were alike set at naught, and at length, in the early part of 1632, when trying to stop the progress of the victorious Swedes into Bavaria, he was killed by a cannon-shot, from which all the relics he carried about him, all the saints to whom he paid his homage, could not save him. The Protestant allies occupied the whole country between the Elbe and the Rhine, and after Tilly's death overran Bavaria.

Wallenstein, whose boundless ambition, enormous wealth, and intolerable insolence had fixed a great

gulf between him and the Emperor, was the only man who could save the Empire. An appeal was made to him, and he took command of the Imperial armies, unshackled by a single condition. At Nuremburg, where he was entrenched, he had the satisfaction of beating off the army of Gustavus, who, burning under the desire to wipe off the disgrace of even partial defeat, attacked him at Lutzen, on the 16th of November, 1632. The battle was one of the most bloody on record. For nine hours it was fought with obstinate fury on both sides, Gustavus Adolphus fell mortally wounded in the middle of it, and the Swedes fought for revenge as well as for victory. Prince Bernhard of Saxe Weimar took the command after the king's death, and the result was that the Imperialists were totally routed.

Happily, there remained, in spite of the grievous loss sustained in the death of Gustavus, good men and true among the Swedes, who resolved to carry out the policy of their beloved king. Chancellor Oxonstiern, Gustavus's friend and counsellor, was chosen to manage the war, and he gathered up in his strong hand the reins which threatened to float loosely and disordered. At the end of 1634 another event conspired to help him. The Emperor Ferdinand, jealous of the Duke of Friedland, and suspicious of his intentions to snatch the crown for himself, procured his assassination. But the King of Hungary, son to the Emperor, took Wallenstein's place, and at Nordlingen defeated the confederates with so severe a loss, that all but the French and Swedes and the Landgraf of Hesse were fain to make peace with the Emperor. This was done by the Treaty of Prague, in 1635.

During the whole of Richelieu's life the war went on, bringing out generals like the Great Condé, Turenne, and Torstensohn, and winning, on the whole, fresh laurels for the French and Swedish arms; and when Richelieu and his master died in 1643, it was found that Cardinal Mazarin, who governed for the minor Louis XIV., was prepared to carry out their plan for humbling the House of Austria.

Under the conduct of Condé and Turenne, and the Swedish generals, the Thirty Years' War continued to ruin and desolate the face of Germany, till in 1648, the Emperor Ferdinand III., weary of continuous defeat, exhausted as to his resources, and unable to cope with the powers against him, sued for peace, and the Peace of Westphalia, which secured civil and religious liberty to the Protestant subjects of the Empire, was signed at Munster, and brought the long succession of years of war to a close.

See:—Cassell's Universal History; Hallam, Middle Ages.

GREEK.—III.

[*Continued from p. 81.*]

CASE-ENDINGS OF THE DECLENSIONS.

We have already said that there are in Greek three declensions; the essential forms of two of these three declensions are contained in the definite article, which was brought under your notice in the last lesson (p. 81), thus:—

CASE-ENDINGS OF FIRST AND SECOND DECLENSIONS.

	First.	*Second.*	*Second.*	
		Singular.		
	FEM.	MAS.	NEUT.	*English Equivalent.*
Nom.	-η	-ος	-ον	
Gen.	-ης	-ου	-ου	of.
Dat.	-ῃ	-ῳ	-ῳ	to, for, by, with.
Acc.	-ην	-ον	-ον	
		Plural.		
Nom.	-αι	-οι	-α	
Gen.	-ων	-ων	-ων	
Dat	-αις	-οις	-οις	
Acc.	-ας	-ους	-α	
		Dual.		
Nom. Acc.	-α	-ω	-ω	
Gen. Dat.	-αιν	-οιν	-οιν	

Learn these case-endings very carefully. You will then, as it were by anticipation, have acquired the chief forms of the first and second declensions. And observe, here, some general facts, the recollection of which you will hereafter find very useful. These endings are signs or tokens of the feminine gender, namely, -η, -ης, -ῃ, -ην, -αι, -αις, -ας. These are usually signs or tokens of the masculine gender, namely, -ος, -ου, -ῳ, -ον, -οι, -οις, -ους. These are marks of the neuter gender, namely, -ον, -α. Then, in regard to the cases, observe that -ης and -ου are indications of the genitive singular, while the iota subscript is the mark of the dative singular, and -ων of the genitive plural.

In the article, as in nouns and adjectives, the nominative and accusative neuter in the singular, plural, and dual numbers are the same.

You will ascertain how much you have become master of, and be aided in fixing your acquirement in your memory, if, before you proceed to the declensions considered separately, you now study this

GENERAL VIEW OF THE THREE DECLENSIONS.

	First.		*Second.*		*Third.*
			Singular.		
	MAS.	FEM.	MAS.	NEUT.	MAS. FEM. NEUT.
Nom.	-ης -ας	-η -α	-ος	-ον	-α, -ι, -υ, -ω, -ν, -ξ, -ρ, -ς, -ψ
Gen.	-ου	-ης -ας	-ου		-ος
Dat.	-ῃ -ᾳ	-ῃ -ᾳ	-ῳ		-ι
Acc.	-ην -αν	-ην -αν	-ον		-α -ν {and same as the Nom. in neuter nouns.}

	Plural.			
	MAS. FEM.	MAS. NEUT.	MAS. FEM.	NEUT.
Nom.	-αι	-οι -α	-ες	-α
Gen.	-ων	-ων	-ων	-ων
Dat.	-αις	-οις	-σι, -εσι	-σι
Acc.	-ας	-ους -α	-ας	-α
	Dual.			
	M. F. N.	M. F. N.	M. F. N.	
Nom. Acc.	-α	-ω	-ε	
Gen. Dat.	-αιν	-οιν	-οιν	

These are the case-endings of the nouns of the three declensions. Knowing these, you can easily form a noun or give any case and number of a noun. Suppose the noun is τιμή, *honour*: τιμή consists of two parts, namely, the stem τιμ-, and the nominative singular termination -η. Take from τιμη the case-ending, you have the stem τιμ-; add to the stem τιμ- the case-ending, you have τιμή, the nominative singular. You will see this exemplified in this table.

STEM AND CASE-ENDINGS OF A NOUN.

τιμή, *honour*.

	Singular		
	STEM	CASE-ENDINGS	THE TWO UNITED.
Nom.	τιμ-	-η	τιμ-ή.
Gen.	τιμ-	-ης	τιμ-ῆς.
Dat.	τιμ-	-ῃ	τιμ-ῇ.
Acc.	τιμ-	-ην	τιμ-ήν.
		Plural.	
Nom.	τιμ-	-αι	τιμ-αί.
Gen.	τιμ-	-ων	τιμ-ῶν.
Dat.	τιμ-	-αις	τιμ-αῖς.
Acc.	τιμ-	-ας	τιμ-άς.
		Dual.	
Nom. Acc.	τιμ-	-α	τιμ-ά.
Gen. Dat.	τιμ-	-αιν	τιμ-αῖν.

Let us throw away the hyphen, and then from the common form τιμ- we have τιμή, τιμῆς, τιμῇ, τιμήν, τιμαί, τιμῶν, τιμαῖς, τιμάς, τιμά, τιμαῖν. This explanation will in substance serve for the nouns and adjectives generally.

THE FIRST DECLENSION.

The first declension has four terminations in the nominative singular, namely, -η, -ᾰ (or -ᾱ), -ης, and -ᾱς. Of these four terminations, two—namely, -η and -α—are feminine; and two—namely, -ης and -ᾱς—are masculine.

CASE-ENDINGS OF THE FIRST DECLENSION.

	Singular.				Plural.	Dual.
	FEMININE.		MASCULINE.		M. F.	M. F.
Nom.	-η	-α	-ης	-ᾱς	-αι	-α
Gen.	-ης	-ας, -ης	-ου		-ων	-αιν
Dat.	-ῃ	-ᾳ, -ῃ	-ῃ	-ᾳ	-αις	-αιν
Acc.	-ην	-αν	-ην	-ᾱν	-ας	-α
Voc.	-η	-α	-η, -α	-ᾱ	-αι	-α

FEMININE NOUNS.

		Singular.			
		Justice.	*Country.*	*Shade.*	*A Muse.*
Nom.	ἡ	δίκ-η.	χώρ-ᾱ.	σκί-ᾱ	Μοῦσ-α.
Gen.	τῆς	δίκ-ης.	χώρ-ας.	σκί-ας.	Μούσ-ης.
Dat.	τῇ	δίκ-ῃ.	χώρ-ᾳ.	σκί-ᾳ.	Μούσ-ῃ.
Acc.	τὴν	δίκ-ην.	χώρ-αν.	σκί-αν.	Μοῦσ-αν.
Voc.		δίκ-η.	χώρ-α.	σκί-α.	Μοῦσ-α.
		Plural.			
Nom.	αἱ	δίκ-αι.	χῶρ-αι.	σκί-αι.	Μοῦσ-αι.
Gen.	τῶν	δικ-ῶν.	χωρ-ῶν.	σκι-ῶν.	Μουσ-ῶν.
Dat.	ταῖς	δίκ-αις.	χώρ-αις.	σκί-αις.	Μούσ-αις.
Acc.	τὰς	δίκ-ας.	χώρ-ας.	σκί-ας.	Μούσ-ας.
Voc.		δίκ-αι.	χῶρ-αι.	σκί-αι.	Μοῦσ-αι.
		Dual.			
N.A.V.	τὰ	δίκ-α.	χώρ-α.	σκί-α.	Μούσ-α.
G.D.	ταῖν	δίκ-αιν.	χώρ-αιν.	σκί-αιν.	Μούσ-αιν.

In the same way are declined

CONTRACTED FEMININE NOUNS.

	Singular.	
	A fig-tree.	*A mina.*
Nom.	(συκέ-α) συκ-ῆ.	(μνά-α) μν-ᾶ.
Gen.	(συκέ-ας) συκ-ῆς.	(μνά-ας) μν-ᾶς.
Dat.	(συκέ-ᾳ) συκ-ῇ.	(μνά-ᾳ) μν-ᾷ.
Acc.	(συκέ-αν) συκ-ῆν.	(μνά-αν) μν-ᾶν.
Voc.	(συκέ-α) συκ-ῆ.	(μνά-α) μν-ᾶ.
	Plural.	
Nom.	(συκέ-αι) συκ-αῖ.	(μνά-αι) μν-αῖ.
Gen.	(συκέ-ων) συκ-ῶν.	(μνά-ων) μν-ῶν.
Dat.	(συκέ-αις) συκ-αῖς.	(μνά-αις) μν-αῖς.
Acc.	(συκέ-ας) συκ-ᾶς.	(μνά-ας) μν-ᾶς.
Voc.	(συκέ-αι) συκ-αῖ.	(μνά-αι) μν-αῖ.
	Dual.	
N.A.V.	(συκέ-α) συκ-ᾶ.	(μνά-α) μν-ᾶ.
G.D.	(συκέ-αιν) συκ-αῖν.	(μνά-αιν) μν-αῖν.

A mina is a Greek coin, equal to about £4 English. Its root is akin to the English *money*, the Latin *moneta*, and the Hebrew *maneh*.

From the foregoing examples it will be seen that

(i.) Nouns ending in η retain the η in all the cases of the singular number.

(ii.) Nouns ending in α preceded by ρ or a vowel retain the α. (So also do some proper names in ᾱ, as Ἀνδρομέδᾱ, *Andromeda*: Λήδᾱ, *Leda*; Φιλομήλᾱ, *Philomela*.) After any consonant but ρ the α is changed to η in the genitive and dative singular.

(iii.) When α is preceded by ε or α, a contraction takes place, according to the rules laid down above (*vide* lesson I., p. 22).

According to these paradigms, the feminine gender of adjectives of three terminations is declined. It ends in α when preceded by ε, ι, or ρ.

The adjectives in *-oos* have *-oa* in the feminine when *o* is preceded by *ρ*; otherwise they end in *-οη*; thus ἀθρόα, *dense*; ὀγδόη, *eighth*.

NOUNS AND ADJECTIVES COMBINED.

FIRST DECLENSION.

Singular.

	Fair honour.	*Just opinion.*	*Hateful land.*
Nom.	καλὴ τιμή.	δικαία γνώμη.	ἐχθρὰ χώρα.
Gen.	καλῆς τιμῆς.	δικαίας γνώμης.	ἐχθρᾶς χώρας.
Dat.	καλῇ τιμῇ.	δικαίᾳ γνώμῃ.	ἐχθρᾷ χώρᾳ.
Acc.	καλὴν τιμήν.	δικαίαν γνώμην.	ἐχθρὰν χώραν.
Voc.	καλὴ τιμή.	δικαία γνώμη.	ἐχθρὰ χώρα.

Plural.

Nom.	καλαὶ τιμαί.	δίκαιαι γνῶμαι.	ἐχθραὶ χῶραι.
Gen.	καλῶν τιμῶν.	δικαίων γνωμῶν.	ἐχθρῶν χωρῶν.
Dat.	καλαῖς τιμαῖς.	δικαίαις γνώμαις.	ἐχθραῖς χώραις.
Acc.	καλὰς τιμάς.	δικαίας γνώμας.	ἐχθρὰς χώρας.
Voc.	καλαὶ τιμαί.	δίκαιαι γνῶμαι.	ἐχθραὶ χῶραι.

Dual.

N.A.V.	καλὰ τιμά.	δικαία γνώμα.	ἐχθρὰ χώρα.
G.D.	καλαῖν τιμαῖν.	δικαίαιν γνώμαιν.	ἐχθραῖν χώραιν.

Write out in full the following nouns:—Μήδεια, *Medea*; ἀλήθεια, *truth*; μοῖρα, *fate*: ἄρουρα, *arable land*; δόξα, *opinion*. Write out also, in pairs, as in the last table, these nouns and adjectives, namely, μικρὰ μανία, *slight madness*; μακρὰ λύπη, *long grief*; βραχεῖα ἡδονή, *short pleasure*; πᾶσα κακία, *all wickedness*.

VOCABULARY.

Ἄγω, I lead, drive.
Ἀδικία, -ας, ἡ, injustice.
Ἀδολεσχία, -ας, ἡ, garrulity, talkativeness.
Ἀληθίνη, true.
Ἀπέχομαι, I keep myself from, abstain from.
Ἀρετή, -ῆς, ἡ, virtue.
Βία, -ας, ἡ, force.
Βοήθεια, -ας, ἡ, assistance.
Γίγνομαι, I become, I arise.
Διαβολή, -ης, ἡ, calumny.
Δίκη, -ης, ἡ, justice.
Εἴκω, I yield.
Ἐπαγγέλλομαι, I promise.
Ἐπάγω, I bring on.
Ἡδονή, -ῆς, ἡ, pleasure.
Θεραπεύω, I attend to, heal, court.
Καί, and.
Κακία, -ας, ἡ, wickedness.
Καρδία, -ας, ἡ, the heart.
Καταφυγή, -ης, ἡ, a refuge.
Λύμη, -ης, ἡ, outrage.
Λύπη, -ης, ἡ, grief.
Λύρα, -ας, ἡ, a lyre.
Λύω, I undo, loose, dissipate.
Μέριμνα, -ης, ἡ, anxious care.
Πείθομαι (with dat.), I am persuaded, I believe, trust, obey.
Πενία, -ας, ἡ, poverty.
Πλεονεξία, -ας, ἡ, avarice.
Πολλάκις, often.
Συνήθεια, -ας, ἡ, intercourse, companionship.
Τείρω, I rub (Latin, tero), grieve.
Τίκτω, I bring forth.
Τρυφή, -ῆς, ἡ, luxury.
Φιλία, -ας, ἡ, friendship.
Χαλεπή, hard, troublesome.
Ὡς, as.

EXERCISE 3.

Translate into English:—

1. Μὴ εἶκε τῇ βίᾳ. 2. Ἡ λύρα μερίμνας λύει. 3. Ἡ φιλία ἐπαγγέλλεται καταφυγὴν καὶ βοήθειαν. 4. Ἡ μέριμνα τὴν καρδίαν ἐσθίει. 5. Θεραπεύετε τὰς Μούσας. 6. Μὴ πείθου διαβολαῖς. 7. Ἡ δίκη πολλάκις τῇ ἀδικίᾳ εἴκει. 8. Πολλάκις χαλεπῇ πενίᾳ τειρόμεθα. 9. Τὴν ἀδολεσχίαν φεύγετε. 10. Ἡ κακία λύπην ἐπάγει. 11. Ἡ τρυφὴ ἀδικίαν καὶ πλεονεξίαν τίκτει. 12. Φεῦγε τὴν τρυφὴν ὡς λύμην. 13. Διὰ ἀρετῆς καὶ συνηθείας ἀληθίνη φιλία γίγνεται.

EXERCISE 4.

Translate into Greek:—

1. Abstain from force. 2. He abstains from force. 3. He does not abstain from force. 4. They abstain from force. 5. Avoid injustice. 6. You avoid injustice. 7. I avoid injustice as madness. 8. Force brings grief. 9. Through justice pleasure arises. 10. True friendships arise through virtue. 11. The heart is grieved by poverty. 12. Anxious cares are dissipated by the lyre.

ETYMOLOGICAL VOCABULARY.

ΔΊΚΗ, justice, judgment.
Δίκησις, vengeance.
Δικήφορος, bringing punishment, *or* retribution.
Δικίδιον, a (trumpery) lawsuit.
Δικογραφία, an indictment.
Δικολογέω, I speak in a court of justice.
Δικόλογος, a pleader.
Δικομαχέω, I litigate.
ΚΑΚΌΣ, bad, wicked.
Κακία, wickedness, baseness.
Κακίζω, I make wicked, revile.
Κακισμός, reviling, blame.
Κακοβουλία, bad counsel, folly.
Κακόγαμος, unhappily married.
Κακογείτων, a bad neighbour.
Κακογενής, of base origin.
Κακογλωσσία, evil speaking.
Κακόγλωσσος, an evil speaker.
Κακοδαίμων, having an evil spirit, unhappy, wretched.
ΦΊΛΟΣ, a friend.
Φιλία, friendship.
Φιλικός, befitting a friend.
Φίλιος, friendly, *or* friend-like.
Φιλιππία, fondness for horses.
Φιλογέλοιος, fond of laughter, sportive.
Φιλόδημος, loving the people (Latin, publicola).
Φιλόδικος, fond of lawsuits.

N.B.—Observe especially, that when φίλος, *in composition*, is a *prefix*, it is *active*; but when a *suffix*, it is *passive*, as:—Φιλόθεος is *loving God*; but θεόφιλος is *beloved by God*.

SECONDARY COMPONENTS.

Γάμος, marriage.
Γείτων, a neighbour.
Γέλοιος, laughable.
Γέλως, laughter, mirth.
Γέννησις, begetting, *from* γεννάω, I beget.

Γλῶσσα (or γλῶττα), a tongue.	Ἵππος, a horse.
Δαίμων, a divinity.	Μάχη, a fight, a contest.
Δῆμος, the people.	Φορός, bearing, *from* φέρω, I bear, produce.

By the help of these "Secondary Components" and the Vocabulary, the learner ought to be able to give the meanings of the several *derivative* words. Words, the roots of which have occurred previously, as γραφία in δικογραφία, are not repeated under the head of "Secondary Components," unless for special reasons.

In ἐπάγω you see a preposition prefixed to a verb; ἐπάγω is made up of ἐπί, *upon* or *to*, and ἄγω (Latin, ago), *I lead* or *conduct*. Hence ἐπάγω means *I lead to*. Instead of ἐπί, we might have had the preposition ἀπό, as in ἀπάγω. Now ἀπό means *from, away from*; accordingly, ἀπάγω is, *I lead away*. With ἀνά, which denotes *motion upwards*, ἄγω in the form of ἀνάγω, signifies, *I lead up*; and with κατά, as in κατάγω, the same root means, *I lead down*. You thus see how the prepositions are used as prefixes, and how, as such, they modify the signification and increase the vocabulary. A comparison of the English "meanings" with the Greek verbs as just given will show that what we express by an uncombined verb and an adverb or preposition, the Greeks expressed by a verb and a prefix in combination.

That the learner may have sufficient practice in declining feminine nouns of the first declension, he should write out the nouns and adjectives in the following vocabulary according to the models given above.

VOCABULARY.

Ἀστραπή, -ῆς, ἡ, lightning.	Ἐσθλή, good, honest.
Ἀτιμία, -ας, ἡ, dishonour.	Εὐθύνω, I make straight, make right.
Βασίλειᾰ, -ας, ἡ, a queen.	Καλή, beautiful.
Βασιλεία, -ας, ἡ, a kingdom.	Κατέχω, I hold back.
Βλαβή, -ῆς, ἡ, injury.	Λαμπρά, shining, splendid.
Βροντή, -ῆς, ἡ, thunder.	Μεταβολή, -ῆς, ἡ, change.
Γλῶσσα, -ης, ἡ, a tongue, speech.	Πίπτω, I fall.
Δίαιτα, -ης, ἡ, manner of life (Eng. diet).	Ῥᾳδίως, easily.
Δόξα, -ης, ἡ, glory.	Σκολιά, crooked, wrong.
Εὐνομία, -ας, ἡ, regard for law.	Στολή, -ῆς, ἡ, a robe.
	Τύχη, -ης, ἡ, fortune, fate.
	Φέρω (Latin fero), I bear.

EXERCISE 5.

Translate into English:—

1. Τῇ κακίᾳ ἀτιμία ἕπεται. 2. Ῥαδίως φέρε τὴν πενίαν. 3. Βροντὴ ἐκ λαμπρᾶς ἀστραπῆς γίγνεται. 4. Ἡ ἀρετὴ ἐσθλὴν δόξαν ἔχει. 5. Εὐνομία εὐθύνει δίκας σκολιάς. 6. Δίκη δίκην τίκτει καὶ βλαβὴ βλαβήν. 7. Ἀγαθὴν δίαιταν ἄγε. 8. Κάτεχε τὴν γλῶσσαν. 9. Ἡ τύχη πολλάκις μεταβολὰς ἔχει. 10. Τὴν πενίαν φέρετε. 11. Αἱ λαμπραὶ τύχαι ῥαδίως πίπτουσιν. 12. Φέρε τὰς τύχας. 13. Ἡ ἀρετὴ οὐκ εἴκει ταῖς τύχαις. 14. Ἀπέχεσθε τῶν χαλεπῶν μεριμνῶν. 15. Ἡ βασίλεια λαμπρὰν βασιλείαν ἔχει. 16. Ἡ στολὴ ἐστι καλή. 17. Καλὰς στολὰς ἔχομεν.

EXERCISE 6.

Translate into Greek:—

1. Flee cares. 2. Baseness begets dishonour. 3. Virtue follows fame. 4. They bear poverty easily. 5. Poverty is borne easily. 6. You bear poverty easily. 7. Thou hast changes. 8. Abstain from baseness. 9. They have a beautiful robe. 10. Do not yield to fortune. 11. They yield to fortune readily. 12. Do ye restrain (*hold back*) the tongue (that is, in English, *your tongue*). 13. Wrong judgments are made right.

Having treated of feminine nouns of the first declension, we now pass on to

MASCULINE NOUNS OF THE FIRST DECLENSION.

EXAMPLES.

Singular.

	A citizen.	*A youth.*	*Mercury.*		
Nom.	πολίτης (ῑ).	νεᾱνίᾱς.	Ἑρμέας.	*contr.*	Ἑρμῆς.
Gen.	πολίτου.	νεᾱνίου.	Ἑρμέου.	„	Ἑρμοῦ.
Dat.	πολίτῃ.	νεᾱνίᾳ.	Ἑρμέᾳ.	„	Ἑρμῇ.
Acc.	πολίτην.	νεᾱνίᾱν.	Ἑρμέαν.	„	Ἑρμῆν.
Voc.	πολῖτα.	νεᾱνία.	Ἑρμέα.	„	Ἑρμῆ.

Plural.

Nom.	πολῖται.	νεᾱνίαι.	Ἑρμέαι.	„	Ἑρμαῖ.
Gen.	πολιτῶν.	νεᾱνιῶν.	Ἑρμεῶν.	„	Ἑρμῶν.
Dat.	πολίταις.	νεᾱνίαις.	Ἑρμέαις.	„	Ἑρμαῖς.
Acc.	πολίτᾱς.	νεᾱνίᾱς.	Ἑρμέας.	„	Ἑρμᾶς.
Voc.	πολῖται.	νεᾱνίαι.	Ἑρμέαι.	„	Ἑρμαῖ.

Dual.

N.A.V.	πολίτᾱ.	νεᾱνίᾱ.	Ἑρμέα.	„	Ἑρμᾶ.
G.D.	πολίταιν.	νεᾱνίαιν.	Ἑρμέαιν.	„	Ἑρμαῖν.

The vocative of such nouns as have -ης in the nominative singular ends in -ᾰ in the following cases, namely:—

1. In all nouns in -της, as τοξότης, *an archer*, vocative τοξότα; προφήτης, *a foreteller, a prophet*, vocative προφῆτα.

2. In all substantives in -ης compounded of a substantive and a verb, as γεωμέτρης, *a land-measurer, a geometrician*, vocative γεωμέτρα; μυροπώλης, *a perfumer*, μυροπῶλα.

VOCABULARY.

Ἀδολέσχης, -ου, ὁ, a chatterer.	Ἀκροάτης, -ου, ὁ, a hearer.
Ἀκούω (with Gen. or Acc.), I hear.	Βλάπτω, I injure.
	Βορέας,* north wind.

* Declined like Ἑρμέας uncontracted.

Δεσπότης, -ου, ὁ, a master (Eng. despot).

Εὐκοσμία, -ας, ἡ, decorum, politeness.

Ἡσυχία, -ας, ἡ, tranquillity; ἡσυχίαν ἄγειν, to be quiet.

Θάλασσα, -ης, ἡ, the sea.

Θεάτης, -ου, ὁ, a spectator (Eng. theatre).

Μανθάνω, I learn.

Μέλει (with Gen. of the thing, and Dat. of the person), it concerns; μέλει μοι, I have to do with.

Ναύτης, -ου, ὁ, a sailor.

Ὀρέγομαι, I reach towards, strive after (with Gen.).

Πρέπει, it becomes, it is proper.

Προσήκει, it is suitable.

Σοφία, -ας, ἡ, wisdom.

Σπαρτιάτης, -ου, ὁ, a Spartan.

Συβαρίτης, -ου, ὁ, a Sybarite.

Τέχνη, -ης, ἡ, art.

Τρυφήτης, -ου, ὁ, a voluptuary.

EXERCISE 7.

Translate into English:—

1. Μάνθανε, ὦ νεανία, τὴν σοφίαν. 2. Πολίτῃ πρέπει εὐκοσμία. 3. Τὴν νεανίου ἀδολεσχίαν ψέγομεν. 4. Φεῦγε, ὦ πολῖτα, τὴν ἀδικίαν. 5. Τὴν τέχνην τοῦ ναύτου θαυμάζομεν. 6. Ἀκροάταις καὶ θεάταις προσήκει ἡσυχίαν ἄγειν. 7. Φεύγετε, ὦ ναῦται, τὸν Βορέαν. 8. Βορέας ναύτας πολλάκις βλάπτει. 9. Ὀρέγεσθε, ὦ πολῖται, τῆς ἀρετῆς. 10. Οἱ Συβαρῖται τρυφῆται ἦσαν. 11. Ναύταις μέλει τῆς θαλάσσης. 12. Φεῦγε, ὦ Πέρσα. 13. Οἱ Σπαρτιᾶται καλὴν δόξαν ἔχουσιν. 14. Φεύγω νεανίαν τρυφήτην. 15. Τῶν ἀδολεσχῶν ἀπέχου. 16. Ἄκουε, ὦ δέσποτα.

EXERCISE 8.

Translate into Greek:—

1. Flee, O Persians. 2. Bravery becomes citizens. 3. It concerns a citizen to be quiet. 4. O youths, learn wisdom. 5. They learn wisdom. 6. You learn wisdom. 7. I learn wisdom. 8. Wisdom is learnt. 9. Decorum becomes a youth. 10. O north wind, injure not the sailor. 11. O sailor, avoid (φεύγω) the north wind. 12. The north wind is avoided. 13. O Spartan, strive after glory. 14. Chatterers, be quiet. 15. Abstain from a chatterer.

VOCABULARY.

Δικαιοσύνη, -ης, ἡ, justice.

Ἐπιμέλομαι (with Gen.), I care for.

Ἐραστής, -οῦ, ὁ, a lover, a friend.

Ἐστί (with Gen.), it is the duty of.

Θαυμαστή, admirable.

Κλέπτης, -ου, ὁ, a thief.

Κριτής, -οῦ, ὁ, a judge.

Μάχομαι, I fight.

Ναυαγία, -ας, ἡ, shipwreck, (literally ship-break).

Οἰκέτης, -ου, ὁ, a servant.

Στρατιώτης, -ου, ὁ, a soldier.

Τεχνίτης, -ου, ὁ, an artist.

Τρέφω, I nourish, bring up.

Ψεύστης, -ου, ὁ, a liar.

EXERCISE 9.

Translate into English:—

1. Ἡ Σπαρτιατῶν ἀρετὴ θαυμαστὴ ἦν. 2. Φεῦγε, ὦ νεανία. 3. Φεύγετε, ὦ ἐρασταί. 4. Οἱ κλέπται φεύγονται. 5. Κριταῖς πρέπει δικαιοσύνη. 6. Ἔστι τῶν στρατιωτῶν περὶ τῶν πολιτῶν μάχεσθαι. 7. Φεῦγε ψεύστας. 8. Ἔστι δεσπότου ἐπιμέλεσθαι τῶν οἰκετῶν. 9. Μὴ πίστευε ψεύστῃ. 10. Τεχνίτην τρέφει ἡ τέχνη. 11. Ἐκ ψευστῶν γίγνονται κλέπται. 12. Οἱ Σπαρτιᾶται δόξης καὶ τίμης ἐρασταὶ ἦσαν. 13. Ἐκ βορέου πολλάκις γίγνεται ναυαγία. 14. Θαυμάζετε τὴν Ἑρμοῦ τέχνην.

EXERCISE 10.

Translate into Greek:—

1. The lovers of glory flee not. 2. Liars are not lovers of virtue. 3. The virtue of the Spartan was admirable. 4. O Spartans, believe not liars. 5. The art of (Mercury) Hermes was admirable. 6. They admire the virtue of the Spartans. 7. O Spartan, avoid a liar. 8. It is the duty of a judge to care for his servant. 9. It is the duty of servants to care for their masters. 10. The arts nourish artists. 11. It becomes the soldiers to fight for the citizens. 12. Be quiet, O north wind. 13. I admire Mercury.

KEY TO EXERCISES.

Ex. 1.—1. Always speak the truth. 2. Rejoice [joj. 3. Follow. 4. Do not complain. 5. I live pleasantly. 6. I am being well educated. 7. You write beautifully. 8. If you write ill, you are blamed. 9. He hastens. 10. He fights bravely. 11. If you flatter, you do not speak the truth. 12. If you flatter, you are not believed. 13. We flee. 14. If we flee, we are pursued. 15. You flee badly (like cowards). 16. If you are idle, you are blamed. 17. If you fight bravely, you are admired. 18. If they flatter, they do not speak the truth. 19. It is not well to flee. 20. It is well to fight bravely. 21. If you are pursued, do not flee. 22. Fight bravely. 23. If they are idle, they are blamed. 24. If you speak the truth, you are believed. 25. Always excel. 26. Eat and drink, and play, moderately.

Ex. 2.—1. Ἀληθεύω. 2. Ἀληθεύεις. 3. Ἀληθεύει. 4. Ἀληθεύομεν. 5. Ἀληθεύετε. 6. Ἀληθεύουσι. 7. Εἰ ἀληθεύω πιστεύομαι. 8. Μὴ μάχεσθε. 9 Μάχονται. 10. Ἕπεσθε. 11. Ἕπῃ. 12. Ἕπεσθε. 13. Παίζει. 14. Φεύγουσι. 15. Εἰ φεύγουσι διώκονται. 16. Θαυμάζομαι. 17. Θαυμάζονται. 18. Εἰ βλακεύουσιν οὐ θαυμάζονται. 19. Εὖ ἔχει ἀνδρείως μάχεσθαι. 20 Μετρίως ἐσθίει καὶ πίνει. 21. Οὐ σπεύδουσι. 22. Εἰ κολακεύεις οὐ θαυμάζῃ. 23. Καλῶς γράφει. 24. Γράφουσι κακῶς. 25. Εὖ ἔχει ἀεὶ ἀριστεύειν. 26. Μετρίως βιοτεύετε. 27. Ἄγαν ἐσθίουσι.

ELECTRICITY.—VI.

(Continued from p. 86.)

VARIOUS METHODS OF COUPLING UP CELLS — EFFECTIVE RESISTANCE OF CONDUCTORS IN SERIES AND IN PARALLEL—SHUNTS AND THEIR MULTIPLYING POWERS.

A SINGLE Voltaic cell cannot always send a sufficiently strong current through a given resistance. The current that it can send is given by Ohm's law—

$$C = \frac{E}{R + B} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (I.),$$

where C = the current,
" E = the E.M.F.,
" R = the external resistance,
" B = the resistance of the cell.

[illegible] it is desired to send a stronger current through the resistance, more cells must be employed. Any such combination of cells is called a battery. The manner in which a number of cells should be joined up in order that they may be used to the best advantage is an important matter, and it depends upon the nature of the cell and upon the resistance through which it is desired to send the current.

In some cases all the cells should be joined up **in series**; that is to say, the positive element of the first cell should be connected to the negative element of the second, the positive of the second to the negative of the third, and so on; the free element at each end of the series is then joined to the resistance through which the current is to flow. Such an arrangement of the cells is shown in Fig. 19.

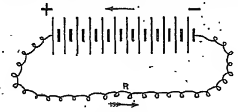


Fig. 19.

The short thick line represents the positive element, and the long thin one the negative element; the curled line represents the external resistance, and the arrows show the direction in which the current flows round the circuit. Both the E.M.F. and the resistance of the battery thus connected up differ from those of a single cell. *The new E.M.F. is the sum of the E.M.F.'s of the separate cells, and the new resistance is the sum of the resistances of the separate cells.*

EXAMPLE 1.—What current will a battery of 12 Grove cells connected in series send through an external resistance of 7 ohms?

The E.M.F. of a Grove being 1·94 volts, and its resistance 0·25 ohms,

The E.M.F. of the battery is clearly

$$1{\cdot}94 \times 12 = 23{\cdot}28 \text{ volts.}$$

And the internal resistance is

$$0{\cdot}25 \times 12 = 3 \text{ ohms.}$$

The current is therefore, by Ohm's law,

$$C = \frac{23{\cdot}28}{7 + 3}$$
$$= 2{\cdot}328 \text{ amperes.} \qquad \textit{Answer.}$$

In some cases all the cells are connected up in parallel; that is to say, all the positive elements are connected together, and all the negative elements are connected together; this arrangement of the cells is shown in Fig. 20. *The E.M.F. of this combination of cells is the same as the E.M.F. of a single cell, but the resistance is the resistance of a single cell divided by the number of cells connected up.*

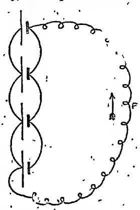


Fig. 20.

EXAMPLE 2.—What current will 4 bichromate cells connected up in parallel send through a resistance of half an ohm?

The E.M.F. of a bichromate being 2 volts, and its resistance 1·5 ohms,

The E.M.F. of the battery is clearly

$$2 \text{ volts.}$$

And the internal resistance is 1·5 divided by 4

$$= 0{\cdot}375 \text{ ohms.}$$

The current is therefore

$$C = \frac{2}{0{\cdot}5 + 0{\cdot}375}$$
$$= 2{\cdot}286 \text{ amperes.} \qquad \textit{Answer.}$$

Instead of having all the cells connected up in series or all in parallel, it is often necessary to have some in series, and some in parallel in order

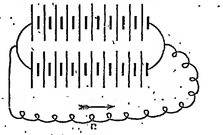


Fig. 21.

to obtain the strongest possible current through a given external resistance. Such combinations of cells are shown in Figs. 21 and 22. In both cases there are twenty cells in the battery, but the E.M.F.'s and the resistances of the two batteries differ.

The E.M.F. of the battery shown in Fig. 22 is five

times the E.M.F. of a single cell, and its resistance is five times the resistance of a single cell divided by four.

The E.M.F. of the battery shown in Fig. 21 is ten

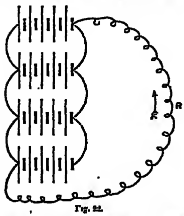


Fig. 22.

times the E.M.F. of a single cell, and its resistance is ten times the resistance of a single cell divided by two.

For any combination of cells the effective E.M.F. is the E.M.F. of a single cell multiplied by the number of cells in series, and the effective resistance is the resistance of a single cell multiplied by the number of cells in series, and divided by the number in parallel.

This rule can be best expressed in symbols, thus:—

Let E = the effective E.M.F. of the battery.
„ R = the „ resistance of the „
„ e = the E.M.F. of a single cell.
„ r = the resistance of a single cell.
„ s = the number of cells in series.
„ p = the „ „ in parallel.

Then for any combination,

$$E = se \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(II.)},$$

and

$$R = \frac{sr}{p} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(III.)}.$$

EXAMPLE 3.—If the cells shown in Figs. 21 and 22 were bichromates, having an E.M.F. of 2 volts and a resistance of 1·5 ohms, what would be the effective E.M.F.'s and resistances in the two cases?

For Fig. 22:—

$$e = 2,$$
$$r = 1·5,$$
$$s = 5,$$
$$p = 4.$$

Substituting these values in the formula $E = se$. and $R = \frac{sr}{p}$, we get

$$E = 5 \times 2.$$
$$= 10 \text{ volts}. \qquad \textit{Answer.}$$

and

$$R = \frac{5 \times 1·5}{4}$$
$$= 1·875 \text{ ohms}. \qquad \textit{Answer.}$$

And in a similar manner we get the following values for the combination of cells shown in Fig. 21:—

$$E = 10 \times 2$$
$$= 20 \text{ volts} \qquad \textit{Answer.}$$

and

$$R = \frac{10 \times 1·5}{2}$$
$$= 7·5 \text{ ohms}. \qquad \textit{Answer.}$$

The possible combinations of the twenty cells, as well as the E.M.F., and resistance corresponding to each combination, is given in the following table:

Number of Cells in Series.	Number of Cells in Parallel.	Effective E.M.F. of Combination.	Effective resistance of Combination.
20	1	40 volts.	30·000 ohms.
10	2	20 „	7·500 „
5	4	10 „	1·875 „
4	5	8 „	1·200 „
2	10	4 „	·300 „
1	20	2 „	·075 „

In order to get the strongest possible current from a given number of cells through a given resistance, the following is the rule:—**Arrange the cells so that the internal resistance is as nearly as possible equal to the given external resistance.** The truth of this rule can be seen from the following example:—

EXAMPLE 4.—With the above cells, what is the strongest current that can be sent through an external resistance of 7·5 ohms, and how must the cells be connected up?

The above combinations give the following currents through the given resistance:—

20 in series gives

$$C = \frac{40}{30 + 7·5} = \frac{40}{37·5}$$
$$= 1·062 \text{ amperes}.$$

10 in series and 2 in parallel gives

$$C = \frac{20}{7·5 + 7·5} = \frac{20}{15}$$
$$= 1·333 \text{ amperes}.$$

5 in series and 4 in parallel gives

$$C = \frac{10}{1·75 + 7·5} = \frac{10}{9·25}.$$
$$= 1·081 \text{ amperes}.$$

4 in series, and 5 in parallel gives

$$C = \frac{8}{1·2 + 7·5} = \frac{8}{8·7},$$
$$= 0·9196 \text{ amperes}.$$

2 in series and 10 in parallel gives

$$C = \frac{4}{\cdot 3 + 7\cdot 5} = \frac{4}{7\cdot 8},$$
$$= \cdot 5129 \text{ amperes.}$$

All in parallel gives

$$C = \frac{2}{\cdot 075 + 7\cdot 5} = \frac{2}{7\cdot 575}$$
$$= \cdot 2642 \text{ amperes.}$$

From this it will be seen that the combination of 10 cells in series and 2 in parallel gives the strongest current through the given resistance, and this is the combination which makes the internal resistence equal to the external resistance as pointed out by the rule. Though the above rule is perfectly true, still it is highly undesirable that we should be obliged to work out the effective resistance of every possible combination in order that we might see which of them was nearest to that of the external circuit. The desired combination can be found at once from the following formula.—

$$s = \sqrt{\frac{NR}{r}} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad \text{(IV.)},$$

where N denotes the total number of cells used.

Applying this formula to the example (4) we get

$$S = \sqrt{\frac{20 \times 7\cdot 5}{1\cdot 5}},$$
$$= \sqrt{100},$$
$$= 10 \text{ cells.}$$

Or we should have 10 cells in series and 2 in parallel, which is the same combination as we have already found works best.

EXAMPLE 5.—20 Grove cells, each having an E.M.F. of 1·94 volts, and a resistance of 0·2 ohm, are joined up so as to send the strongest possible current through a resistance of 1 ohm for 1 hour. What would be the consumption of zinc? Given the electro-chemical equivalent = ·005232 grains.

The first step is to find how the cells must be arranged so as to send the strongest current; in other words, how they must be arranged so that the resistance of the battery shall be as nearly as possible 1 ohm—the resistance of the external circuit. Substituting the above values in equation (IV.) we get

$$s = \sqrt{\frac{20 \times 1}{\cdot 2}},$$
$$= 10.$$

The best arrangement of the cells is therefore to have 10 in series and 2 in parallel. With this arrangement we get from equations (II.) and (III.) the following values for the E.M.F. and resistance of the battery—

$$E = 10 \times 1\cdot 94,$$
$$= 19\cdot 4 \text{ volts,}$$

and

$$R = \frac{10 \times 2}{2},$$
$$= 1 \text{ ohm.}$$

The total current flowing is therefore

$$C = \frac{19\cdot 4}{1 + 1},$$
$$= 9\cdot 7 \text{ amperes,}$$

and since the cells are arranged in two rows, clearly half this current flows through each row; that is to say, 4·85 amperes pass through each cell. The weight of zinc that this current will deposit in each cell in 1 hour is.

$$W = 4\cdot 85 \times 60 \times 60 \times 0\cdot 005199$$
$$= 90\cdot 78 \text{ grains in each cell,}$$

or,

1816 grains in the battery. *Answer.*

EFFECTIVE RESISTANCE OF CONDUCTORS.

The current that is being generated by any cell or combination of cells is directly proportional to the E.M.F. of the combination, and inversely proportional to the total resistence in circuit. We can calculate for any combination of cells the effective E.M.F., but the total resistance in the circuit is composed partly of the resistance of the cells themselves, and partly of the external circuit. It has just been explained how to calculate the resistance of the cells, it now remains to show how the resistance of the other portion of the circuit can be found.

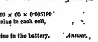


Fig. 23.

The simplest form of circuit is that which consists of a single resistance, such as is shown in Fig. 23. In this case the total resistance in the circuit is the resistance of the battery B, and the resistance R, and the current flowing is therefore

$$C = \frac{E}{B + R}.$$

The next form of circuit—illustrated in Fig. 24 consists of a number of resistances joined one to

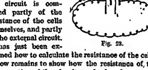


Fig. 24.

the other, so that the whole of the current generated by the battery flows through each in succession; in other words, the resistances r_1, r_2, r_3, r_4, and r_5, are all joined in series. *The effective resistance of such a circuit is the sum of the separate resistances.* Or, if R denotes the total effective resistance of the external circuit, then

$$R = r_1 + r_2 + r_3 + r_4 + r_5 +, \text{etc.} \quad . \; . \; . \; . \quad \text{(V.)}$$

The resistances in the external circuit may, however, be arranged as shown in Fig. 25. In this case the current on leaving the battery divides into four portions, one of which flows through each of the resistances which are now said to be arranged in parallel. If the four resistances are equal, then equal currents will flow through them—that is to say, one-fourth of the total current will flow through each resistance; but if they are not equal, as is more generally the case, then the currents flowing through them will be unequal; the smaller the resistance the larger will be the current that will flow through it.

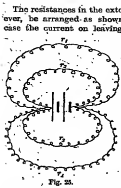


Fig. 25.

Let C = the total current flowing.
" c_1 = the current flowing through r_1.
" c_2 = the " " " r_2.
" c_3 = the " " " r_3.
" c_4 = the " " " r_4.
" R = the effective resistance of the external circuit.
" V = that portion of the total E.M.F. which is used in driving the current through the external circuit.

Remembering that Ohm's law applies to the whole of a circuit and *to any part of it* we have

$$C = \frac{V}{R}.$$

and applying it to each of the circuits we have

$$c_1 = \frac{V}{r_1},$$

and similarly we get

$$c_2 = \frac{V}{r_2},\quad c_3 = \frac{V}{r_3},\quad \text{and } c_4 = \frac{V}{r_4};$$

but

$$C = c_1 + c_2 + c_3 + c_4,$$

therefore

$$\frac{V}{R} = \frac{V}{r_1} + \frac{V}{r_2} + \frac{V}{r_3} + \frac{V}{r_4}.$$

and dividing through by V we get

$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \frac{1}{r_4} \quad \text{(VI.)},$$

or

$$R = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \frac{1}{r_4}} \quad \text{(VII.)}$$

This formula enables us to find the total effective resistance of any number of resistances which are connected up in parallel.

EXAMPLE 6.—What would be the effective resistance of a circuit which consisted of six resistances joined in parallel, the resistances being 5, 2, 4, 8, 10 and 20 ohms respectively?

Substituting these values in the above formula we get

$$\begin{aligned} R &= \frac{1}{\frac{1}{5} + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{10} + \frac{1}{20}} \\ &= \frac{1}{0{\cdot}2 + 0{\cdot}5 + 0{\cdot}25 + 0{\cdot}125 + 0{\cdot}1 + 0{\cdot}05} \\ &= \frac{1}{1{\cdot}225} \\ &= 0{\cdot}8164 \text{ ohm.} \end{aligned}$$

The most general form of a circuit is that which is composed of a number of resistances partly in series and partly in parallel. In such a case both formulæ (V.) and (VI.) must be used in order to find the effective resistance of the circuit.

EXAMPLE 7.—In the circuit illustrated in Fig. 26, what is the effective resistance between the points A and B?

The first step is to find the resistance of the middle circuit joining the points D and B; this is 10 ohms added to the resistance between C and B.

The resistance between C and B is obtained by substituting the values of the resistances in formula (VI.) or (VII.), thus—

$$\begin{aligned} R &= \frac{1}{\frac{1}{18} + \frac{1}{15}} \\ &= \frac{1}{0{\cdot}055 + 0{\cdot}066} \\ &= 8{\cdot}2 \text{ ohms} \end{aligned}$$

We now know the resistance of each of the three circuits joining the points D and B, and the effective

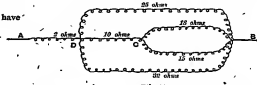


Fig. 26.

resistance between those points can be got as in the previous case, thus—

$$\begin{aligned} R &= \frac{1}{\frac{1}{25} + \frac{1}{18} + \frac{1}{32}} \\ &= \frac{1}{0{\cdot}04 + 0{\cdot}055 + 0{\cdot}0312} \\ &= 7{\cdot}913 \text{ ohms.} \end{aligned}$$

And this, according to rule (V.), must be added to

the resistance between A and D in order to get the total resistance between the points A and B; thus—

$$2 + 7.913$$
$$= 9.913 \text{ ohms. } \quad \textit{Answer.}$$

A special case of formula (VI.) occurs when two points are joined by two resistances in parallel. The effective resistance between the points then becomes

$$R = \frac{r_1 \times r_2}{r_1 + r_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(VIII.)}$$

where r_1 and r_2 are the two resistances. Expressed in words this means that *the effective resistance between the two points is the product of the two resistances divided by their sum.*

LAWS OF SHUNTS.

Under most circumstances it is of importance that we know accurately what strength of current is flowing through any circuit. In order to obtain the necessary information, some form of measuring instrument is inserted in the circuit, so that the current flows through it and works some piece of indicating mechanism. Such instruments can only measure currents up to a certain strength, beyond which they are useless, and it frequently occurs that currents above this strength require measurement. The difficulty is got over by placing across the terminals of the instrument a resistance which will be in parallel with it; the current then divides into two portions, one of which passes through the instrument, and the other through the resistance. Such a resistance is called **a shunt.**

The proportions of the whole current that flow through the instrument and through the shunt depend upon their respective resistances; if the instrument has the smaller resistance the greater portion of the current will pass through it, if the resistances are equal the current will divide into two equal portions, and if the instrument has the greater resistance the greater portion of the current will pass through the shunt. *In every case the current divides into two parts, which are inversely proportional to the resistances through which they flow.* The portions of the current flowing through each path can be best found thus—

Let C = the total strength of the current.
" C_g = the current flowing through the instrument.
" C_s = the current flowing through the shunt.
" G = the resistance of the instrument.
" S = " " " shunt.

Then,

$$\frac{C_g}{C_s} = \frac{S}{G},$$

which can be written in the form

$$\frac{C_g}{C_s + C_g} = \frac{S}{G + S},$$

but,

$$C = C_s + C_g,$$

therefore,

$$\frac{C_g}{C} = \frac{S}{G + S}$$

$$\therefore \quad C_g = C\frac{S}{G + S} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(IX.)},$$

or,

$$C = C_g \frac{G + S}{S} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(X.)}.$$

Equation (IX.) gives us the strength of current that flows through the instrument when a current of known value C is flowing through the circuit, and when G and S are the resistances of the instrument and shunt respectively.

Equation (X.) is, however, the more important one, since the use of the instrument is usually to determine the strength of the whole current that is passing through the circuit. It measures directly that portion of this current which passes through itself C_g, and when this portion is multiplied by the fraction $\frac{G + S}{S}$, the result is the total current flowing. *The fraction* $\frac{G + S}{S}$ *is known as the multiplying power of the shunt;* it is that quantity which the current flowing through the instrument must be multiplied by, in order to obtain the total current flowing through the circuit.

EXAMPLE 8.—A current of half an ampere is found to be passing through an ampere-meter whose resistance is 8 ohms, and on which a shunt is placed which has a resistance of 2 ohms. What is the total current flowing?

Substituting these values in formula (X.), we get

$$C = 0.5 \ \frac{8 + 2}{2},$$
$$= 0.5 \times 5,$$
$$= 2.5 \text{ amperes.} \qquad \textit{Answer.}$$

The multiplying power of this shunt is 5.

It is highly advantageous in practice to have instruments—particularly high resistance galvanometers—provided with a number of shunts which will have convenient multiplying powers. The most convenient multiplying powers are clearly 10, 100, and 1,000, and instrument-makers usually provide each galvanometer they make with these shunts, so that they can be used with four degrees of sensitiveness. The resistance of the shunt which will have any given multiplying power can be easily found when the resistance of the instrument is known, thus:—

Let n be the given multiplying power, then

$$n = \frac{G + S}{S},$$

$$\therefore S = \frac{G}{n - 1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (XI.).$$

EXAMPLE 9.—A galvanometer having a resistance of 9,000 ohms, is to be provided with three shunts having multiplying powers of 10, 100, and 1,000. What must be the resistances of these shunts ?

Substitute the given values in equation (XI.), and we get for a multiplying of 10,

$$S = \frac{9000}{10 - 1},$$
$$= \frac{9000}{9},$$
$$= 1000 \text{ ohms.}$$

For a multiplying of 100,

$$S = \frac{9000}{100 - 1},$$
$$= 90{\cdot}91 \text{ ohms.}$$

And for a multiplying of 1,000,

$$S = \frac{9000}{1000 - 1},$$
$$= 9{\cdot}007 \text{ ohms.}$$

The required shunts have therefore resistances of 1,000, 90·91, and 9·007 ohms respectively.

Answer.

BOTANY.—XVII.

[*Continued from p. 91.*]

CALYCIFLORÆ (*continued*)—GAMOPETALÆ

THE *Saxifragaceæ* are an extensive group of herbs and shrubs, most of which belong to temperate or mountain regions, and few of which are of much use to man except as favourite garden flowers. Their flowers are polysymmetric and mostly white, and the typical formula is (5). 5. 5 + 5. (2), the two carpels being commonly united below, the calyx often partly adherent (half-superior), and the corolla and stamens perigynous. The fruit is a capsule or berry with numerous small albuminous seeds. In addition to the tribe *Saxifrageæ*—including the saxifrages (*Saxifraga*), many of which are tufted or mossy alpine plants, the genus *Astilbe*, to which the so-called "Spiræa japonica" belongs (*see* p. 90, *supra*), and the beautiful Grass of Parnassus (*Parnassia palustris*) of our swamps with remarkable glandular staminodes—the order includes, with others, the tribe *Hydrangeæ*—including the cultivated *Hydrangea* with neuter flowers and petaloid sepals, *Philadelphus*, the mock-orange or "Syringa," and *Deutzia*—and the tribe *Ribesiaceæ*, which includes the gooseberry (*Ribes Grossularia*) and the black and red currants (*R. nigrum* and *R. rubrum*) of our gardens. In this genus much of the pulp in the fruit is formed by the testa of the seeds.

The *Crassulaceæ* are an order of very fleshy plants inhabiting dry climates, especially South Africa, and dry situations, such as roofs and walls, elsewhere. The fleshy leaves have very few stomata, and the flowers are often strictly pentamerous, the formula being 5. 5. 5 + 5. 5, as in the stone-crop (*Sedum acre*). The fruit is a ring of follicles.

The *Droseraceæ*, a family of world-wide distribution, though largely Australian, are bog-plants, to which we have already had occasion to allude (*see* Vol. III., p. 211) on account of the remarkable glandular "tentacles," or marginal processes of the leaves, exuding liquid, from which our British representatives of the group get the name sundew. The Venus's fly-trap of Carolina (*Dionea muscipula*), in which the same insectivorous purpose is effected by instantaneous electric closing of the two halves of the leaf, belongs to the same order as *Drosera*.

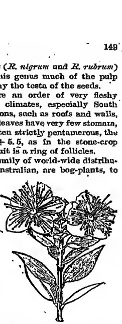


Fig. 76.—THE COMMON MYRTLE (*Myrtus communis*).

The cohort *Myrtales*, with simple, entire leaves, polysymmetric flowers, syncarpous, inferior ovary, central placentation and undivided style, includes the *Rhizophoreæ*, or mangrove tribe, of tropical sea-coasts, the *Myrtaceæ*, the *Lythraceæ*, and the *Onagraceæ*. Though with no British representative, the *Myrtaceæ* form a large tropical and sub-tropical order of shrubs and trees with coriaceous leaves which are generally opposite, dotted with oil-glands and furnished with a strong infra-marginal vein. In addition to the myrtle (*Myrtus communis*), a native of Persia (Fig. 76), the order includes *Eugenia caryophyllata*, a native of the Moluccas, the dried unopened flower-buds of which are well known as cloves; the West Indian *E. Pimenta*, the dried berries of which are called allspice; the numerous and often gigantic species of *Eucalyptus*, the gum-trees, stringy-bark, ironwood, jarrah, etc., of Australia, the largest trees in the world, being sometimes 500 feet high and over 100 feet in girth, yielding useful aromatic oils and magnificent dense timber; and the almost equally huge Brazil-nuts (*Bertholletia*) and Sapucayas (*Lecythis*) of

Brazil. In the two last-named genera the fruit is a large woody capsule containing numerous seeds (the so-called "nuts") with a woody testa. The capsule in the former is round; in the latter it dehisces transversely, whence the name monkey-pot. The pomegranate (*Punica Granatum*), possibly native to Socotra and seemingly belonging to this order, has an anomalous fruit, with astringent rind, consisting of two tiers of carpels, three below with central, and from five to seven above with parietal, placentation.

The chief interest attaching to the allied order *Lythraceæ*, which belongs mainly to tropical America, consists in the trimorphic heterogony in the flower of the familiar loosestrife (*Lythrum*) of our river-banks, already mentioned (Vol. IV., p. 186). The formula of this flower is (6).6.6 + 6.(2), the single style in each of the three forms being of a different length from either of the two whorls of stamens in that plant, but of the same length as one whorl in each of the other two forms, and cross-pollination being secured by the pollen of any stamen being prepotent on the stigma of a style of the same length. Insects visiting the flowers naturally touch the stigmas with the same parts of their bodies as they do the anthers of stamens of the same length in one of the other forms.

The *Onagraceæ* are herbs and shrubs belonging chiefly to temperate climates, with simple, exstipulate leaves, valvate sepals, epigynous insertion, contorted corolla, and exalbuminous seeds. The willow-herbs (*Epilobium*), with willow-like foliage, pink flowers, and long capsular fruits, full of seeds each furnished with a chalazan coma or tuft of hairs, have isomerously tetramerous flowers, the formula being (4).4.4 + 4.(4). The enchanter's nightshade (*Circæa*), a common woodland plant, has flowers dimerous throughout. *Œnothera biennis*, the evening primrose, is so called from its yellow flowers opening at dusk. *Fuchsia*, a favourite genus in our gardens, with a petaloid calyx differing in colour from the corolla and exserted anthers and stigma, is native to Western America, from Mexico to the Straits of Magellan, and to New Zealand.

Fig. 77.—The Carrot (*Daucus Carota*).

A, Inflorescence. B, Fructification. C, A single flower: *stp*, disk. D, Fruit. E, The same in cross section: *h*, primary juga; *s*, long secondary juga; *s*, oil-vittæ beneath the secondary juga.

The cohort *Passiflorales* are mostly herbaceous plants with simple leaves, polysymmetric flowers, often diclinous, and syncarpous ovaries with marginal (generally parietal) placentation. The cohort includes the orders *Passifloraceæ*, *Cucurbitaceæ*, and *Begoniaceæ*. The *Passifloraceæ*, or passion-flowers, are climbing plants, mostly belonging to tropical America, with simple branch tendrils and palmately lobed, stipulate leaves, which were named by Spanish Jesuits from a fancied representation of the instruments of our Lord's Passion in the parts of the flower. The five petaloid sepals, each of which ends in a little hook, and the five petals, generally similarly coloured, represented the apostles, omitting St. Peter and Judas; the characteristic circle of coloured filamentous organs, each containing spiral vessels, known as the *corona*, in which resides the perfume of the flower, figured the crown of thorns; the five versatile anthers, dehiscing longitudinally and outwards, were the five sacred wounds; and the three spreading clavate styles, the three nails; whilst to the pious imagination even the tendrils represented scourges, and the palmatifid leaves, the hands of the scoffers. To the student of plant-structure, in addition to the scented corona, the long gynandrophore, pointing probably to hovering birds as the agents in the cross-pollination of the hanging flowers, is of interest. It forms a stalk between the often per-

sistent calyx and the fruit, a nucilane, which is edible in some species. With the passion-flowers some botanists place the Papaw (*Carica Papaya*), a South American tree, with diclinous flowers and no corona, the leaves of which contain the interesting zymase or ferment "papayin," and have consequently the property of rendering tough meat tender when it is wrapped in them.

The *Cucurbitaceæ*, or cucumber family, are an exceedingly interesting, anomalous, and isolated group. They are climbing herbs, belonging mainly to hot climates and having a watery juice, which is often purgative owing to bitter principles residing especially in the root, pericarp, and seed. The leaves are scattered, petiolate, and palmately veined and lobed. The tendrils, which sometimes branch, have been the subject of much controversy, but appear to be mainly foliar, their base, however, consisting of an extra-axillary branch. The flowers are usually diclinous, polysymmetric, and pentamerous; the corolla consists of five united yellow petals; and the stamens, although originally five, often have the filaments of four of them united in pairs so that there appear to be three, and the anthers fused into a sinuous body with sinuous dehiscence. The inferior fruit is typically a pepo with a horny pericarp and three parietal placentas, and often, as in the pumpkin (*Cucurbita maxima*), reaching a very large size; but in our only British species, the white bryony (*Bryonia dioica*), the fruit is a red berry. In the squirting cucumber (*Ecbalium*) the fruit bursts off its peduncle, violently expelling its seeds, and in *Sechium* there is but one seed, which germinates within the fruit. The fruits of the melon (*Cucumis Melo*), the cucumber (*C. sativus*), the water-melon (*Cucurbita Citrullus*), the gourd (*C. Pepo*), and its variety the vegetable-marrow (*C. Pepo*, var. *ovifera*) are edible; those of *Ecbalium* and *Citrullus Colocynthis* are medicinal; and the fibro-vascular system of those of *Luffa ægyptiaca* forms the so-called "Egyptian loupbar," or towel-gourd.

The *Begoniaceæ*, or elephants' ears, so called from their oblique leaves, are mostly succulent tropical herbs with an acid juice. The affinities of the group are doubtful. Their stems are swollen at the nodes; the leaves are stipulate; and the flowers are monœcious. The staminate flowers have the formula $2 + 2 \;.\; 0 \;.\; 8 \;.\; 0$, and the pistillate ones $5 \;.\; 0 \;.\; 0 \;.\; (\bar{3})$, the perianth leaves being petaloid, the placentation central, and the ovary three-winged externally. Some species have tubers, and many of them freely produce adventitious buds from the cut surfaces of the fleshy leaves, by means of which the plants can be multiplied for our gardens.

The cohort *Ficoidales*—besides the *Mesembryanthaceæ*, of which the ice-plant (*Mesembryanthemum crystallinum*), so-called from its whole surface being studded with ice-like water-vesicles, is a familiar example—contains the well-known family *Cactaceæ*. This family, almost confined in a wild state to the dry parts of tropical America, such as Texas, California, and Mexico, is most anomalous in its vegetative organs. The stem and branches of some genera are flattened and leaf-like; those of others, columnar and many-angled; and others again, globular; whilst the leaves are represented by thorns in clusters. The greater part of these stems, which remain green externally, is cortical parenchyma, often densely filled with crystals of calcium oxalate, and the watery juice distinguishes the order from the spinous Euphorbiaceæ of Africa. The flowers are acyclic and epigynous, the sepals passing gradually into the petals. The formula is $\infty \;.\; \infty \;.\; \infty \;.\; (\overline{3 \text{ or } 6})$. The stamens are often declinate, and the fruit is a unilocular berry. That of *Opuntia vulgaris*, the prickly pear, now naturalised in South Europe, is edible. *O. coccinellifera*, the nopal, is the food-plant of the cochineal insect. Some white-flowered species of *Cereus* open their flowers at night, and give off their perfume in intermittent puffs.

The cohort *Umbellales* have usually exstipulate leaves; umbellate inflorescences; polysymmetric, pentamerous flowers, with an inconspicuous calyx; one whorl of stamens under an epigynous disk; one suspended anatropous ovule in each loculus; and albuminous seeds. This cohort includes the orders *Umbelliferæ*, *Araliaceæ*, and *Corneæ*.

Though some species, such as the giant cow-parsnip (*Heracleum giganteum*) of Siberia, reach a large size, the *Umbelliferæ* are mostly herbaceous, being either annuals or herbaceous perennials. Their stems, partly from the tearing of the copious pith in rapid growth, are fistular, and even the short internodes of the vertical rhizome of *Cicuta virosa* are hollow. No group has more highly organised leaves. They are scattered, exstipulate, and very rarely simple, as in the peltate marsh-pennywort (*Hydrocotyle*), the spinous and amplexicaul eryngo (*Eryngium*), and the perfoliate hare's-ears (*Bupleurum*). Generally they have a much dilated sheath, and are bi- or tri-pinnately divided. The flowers are generally individually small and inconspicuous; but are grouped in flat compound umbels with involucres and involucels. They are pentamerous and usually polysymmetric; but sometimes, as in *Heracleum*, the outer florets become (by unequal growth) monosymmetric and more conspicuous. They are protandrous and are pollinated by insects. The formula is $(5) \;.\; 5 \;.\; 5 \;.\; (\bar{2})$.

The limb of the calyx is generally very small, and the epigynous petals are white or yellow, with a much inflexed or even bifid apex (Fig. 77 c). The cremocarp,

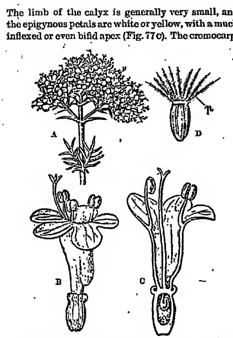


Fig. 78.—Wild Valerian (*Valeriana officinalis*). A, Inflorescence. B, Flower. C, Longitudinal section of the same. D, Fruit with pappus.

the characteristic fruit of the order, consists of two syncarpous carpels suspended from the carpophore, or prolongation of the axis between them, which is often bifurcated at its apex. Each carpel (*mericarp*) commonly bears five longitudinal ridges (*costæ* or *juga*) externally, with sometimes four secondary ones between them, and often with long oil-cavities or *vittæ* in the *valleculæ* or hollows between the ridges (Fig. 77 D, E). Though many *Umbelliferæ* are harmless, and others are rendered so by blanching, many have an acrid narcotic juice in their green parts, others contain gum-resins of medicinal value in their roots, and the aromatic volatile oil in the fruit gives a value to many of them. The order belongs mainly to the North Temperate zone; but the plants that yield the gum-resins belong especially to the warm dry region of Central Asia. The tap-roots of the carrot (*Daucus Carota*), and parsnip (*Pastinaca sativa*), the fruits of the caraway (*Carum Carui*), and coriander (*Coriandrum*), the green parts of the parsley (*Petroselinum*), fennel (*Fœniculum*), and angelica (*Archangelica*), and the blanched petioles of celery (*Apium graveolens*), which when green is poisonous, are articles of food; hemlock (*Conium maculatum*), and water-hemlock (*Cicuta virosa*), are two of the best-known indigenous species which are poisonous; and asafœtida, gum galbanum, and gum ammoniacum are produced by species of *Ferula* and *Dorema* in Thibet, Persia, and Syria.

The *Araliaceæ*, or ivy family, differ from the *Umbelliferæ* in their stems not being fistular, but sometimes woody, and in having usually more than two carpels in the baccate fruit. The ivy (*Hedera Helix*), climbs by means of adventitious rootlets, and has palmately lobed leaves below; but only flowers where it is free from its support, and in this upper region bears unlobed leaves. The perisperm is slightly ruminate. Chinese rice-paper is the pith of *Fatsia papyrifera*, and ginseng, valued in Asia as a medicine, is the root of *Panax Ginseng*.

Cornaceæ, the dogwood family, is a small group of shrubs, inhabiting temperate regions, with simple opposite, exstipulate leaves, flowers sometimes tetramerous, and diclinous and baccate fruit. *Cornus sanguinea* is the common dogwood, and *Aucuba japonica*, a diœcious evergreen species, is familiar in our shrubberies from its cream-spotted leaves.

All the natural orders we have so far been describing belong to the sub-class *Polypetalæ*, though in some few cases the corolla has been gamopetalous. We now come to the second sub-class, the *Gamopetalæ*, a less varied, but in some respects

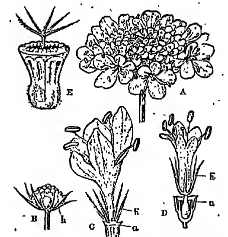


Fig. 79.—Field Scabious (*Scabiosa arvensis*). A, Inflorescence. B, The same when young. C, Ray-floret. D, Disk-floret: *k*, calyx; *a*, involucel. E, Fruit.

more highly specialised assemblage of orders. The gamopetalous corolla is the chief character they have in common; but their stamens are mostly

epipetalous, their gynæcia syncarpous, and their ovules destitute of a primine. Though exceptions are somewhat numerous, the typical floral formula is (5) . [(5) . 5 .] (2). The sub-class is divided into two series, the *Epigynæ* or *Inferæ*, with an inferior ovary, and the *Hypogynæ* or *Superæ*, with a superior one.

In the series *Epigynæ*, the stamens are generally equal in numbers to the petals. The series embraces the three cohorts, *Rubiales*, *Asterales*, and *Campanales*. The first of these, the *Rubiales*, have opposite leaves, and at least two chambers to their ovaries with at least one ovule in each chamber. The cohort includes the two orders *Caprifoliaceæ* and *Rubiaceæ*.

The *Caprifoliaceæ* chiefly belong to temperate or cool regions of the northern hemisphere. They are more abundant in Central Asia, in the north of India, and in America, than in Europe. Certain species pass beyond the limits which seem to be imposed by nature to the family and penetrate into tropical climes; but not being able to support the full rigour of a tropical sun, they take refuge on mountain elevations. They are mostly woody plants, some of them being twiners. The leaves are opposite and generally exstipulate; the flowers perfect and pentamerous; the single whorl of stamens epipetalous; and the fruit a berry. In some species of honeysuckle (*Lonicera*) the leaves are connate and glaucous, several branches may spring from one axil, and the berries of several flowers sometimes become confluent. The elder (*Sambucus nigra*), the flowers of which are used to give a muscat flavour to wines and for perfume, whilst the berries are made into British port wine, is remarkable for the large pith of its shoots, which is employed in the biological laboratory for imbedding. The guelder-rose (*Viburnum Opulus*), in the wild state, has the outer flowers of its corymbose inflorescence neuter with enlarged corollas, a condition which under cultivation extends to all the flowers, making the inflorescence a globular "snow-ball." The little moschatel (*Adoxa moschatellina*) has a remarkable inflorescence of five small sessile green flowers, with bifurcate stamens of which the terminal one is tetramerous, the four lateral ones pentamerous. *Viburnum Tinus*, the laurustinus, *Symphoricarpus racemosus*, the snow-berry, and *Weigelia* are favourite garden shrubs.

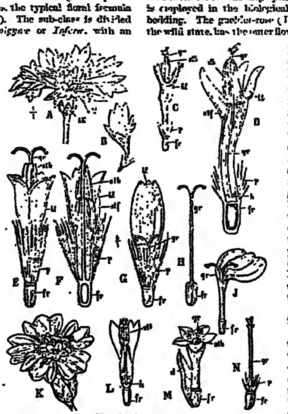


Fig. 80.—Compositæ.

A, Inflorescence of Blue Cornflower (*Centaurea Cyanus*), *in*, Involucre; B, Neuter ray-floret; C, Perfect disk-floret; D, Longitudinal section of the same; E, Gynæceum; E, Perfect disk-floret of the Ragwort (*Senecio Jacobæa*); F, Longitudinal section; G, Female ray-floret; H, Gynæceum; K, Inflorescence of Milfoil (*Achillea millefolium*); M, Disk-floret with pale (*d*); L, Longitudinal section; J, Ray-floret. In all cases *fr* is the ovary (inferior), *p* the pappus, *tl* the corolla, *sth* the anthers, *stf* the filaments, *gr* the style, and *h* honey-glands.

The *Rubiaceæ* are the third largest of the dicotyledonous orders, including over 4,000 species in nearly 350 genera. Their flowers are generally polysymmetric, tetramerous, or pentamerous, and often fragrant or showy; the leaves are opposite and stipulate; and the fruit is mostly dry and two-chambered, with one, two, or many albuminous seeds in each chamber. The order is often subdivided into the *Stellatæ*, herbs of the north temperate zone with interpetiolar foliaceous stipules producing an apparent whorl of sessile leaves, and the *Cinchoneæ*, many of which are trees, which inhabit warm, or even tropical climates, and which have relatively small stipules. To the former group belong the madder (*Rubia*), the woodruff (*Asperula odorata*), strongly perfumed with a substance known as coumarin, the perfume of new-mown hay, and the bed-straws (*Galium*),

to the latter, *Cinchona*, *Coffea*, *Cephaëlis*, *Remijia*, *Uncaria*, *Bouvardia*, and *Gardenia*. Peruvian bark, whence quinine is prepared, is obtained from several species of *Cinchona*, natives of the Andes at altitudes of from 4,000 to 11,000 feet; cuprea-bark, from *Remijia*. Coffee consists of the seeds of *Coffea arabica* and *C. liberica*, two being produced in each berry. Ipecacuanha is the root of the Brazilian *Cephaëlis*, and the astringent gambir is obtained from the Malayan *Uncaria*.

The great cohort *Asterales*, in some respects the most highly organised of plants, consists mainly of herbs. The leaves are exstipulate; the flowers are mostly small and crowded together into involucrate capitula; the calyx has no limb or only a pappus; and the ovary is uniovulate and generally unilocular. The cohort includes the orders *Valerianaceæ*, *Dipsaceæ*, *Calyceraceæ*, and *Compositæ*. Among the *Valerianaceæ* the chief points of structural interest are the pappus (Fig. 78 D), the spur, the reduction in the number of stamens and carpels, and the pendulous, anatropous ovule which forms an exalbuminous seed. In *Valeriana* and *Centranthus* the limb of the calyx is represented by a thickened ring (Fig. 78 C) from which in the fruit stage a plumose pappus is unfolded. Whilst *Valeriana* and *Valerianella* have slight pouches at the base of one petal (Fig. 78 B), in *Centranthus* this is produced into a spur, whence the names "spur-valerian" and *Centranthus* (Greek κέντρον, *kĕntrŏn*, a spur). In the two first-named genera again there are three stamens and three chambers to the ovary, though only one is ovuliferous, whilst in *Centranthus* there is but one stamen and one loculus.

In the *Dipsaceæ*, a small order including the scabious and teazle, in addition to an involucre below the capitulum, there are sometimes paleaceous bracteoles on the common receptacle and each flower is surrounded by an obconic involucel (Fig. 79). The flowers are mostly monosymmetric: the calyx has sometimes setaceous limb-segments; and there are four stamens with exserted anthers, and one pendulous, anatropous ovule forming an albuminous seed. The Latin name of the teazle (*Dipsacus*), meaning "thirsty," is derived from the water that accumulates in the hollow formed by its connate leaves. The tough but elastic bracteoles with hooked points cause the heads of the fuller's teazle (*D. fullonum*) to be used in dressing cloth. The *Calyceraceæ* are a small South American group having pendulous albuminous seeds like *Dipsaceæ*, but with alternate leaves and five stamens which are both monadelphous and syngenesious.

The *Compositæ* (Fig. 80) are by far the largest of the natural orders, including more than 10,000 species, in 800 genera, or about a tenth of all known flowering plants. The order is, however, a very natural one, easily distinguished from all others, but not readily subdivided. It includes but very few arborescent forms. The leaves are generally alternate, and, though often much cut, are seldom truly compound. The branching in the region of the inflorescence is mixed, the capitula, the flowers of which open centripetally, terminate either unbranched scapes, as in the dandelion, or the branches of cymes, which may be corymbose, as in our wild rag-wort (*Senecio Jacobæa*), and its cultivated ally *Cineraria cruenta*. The involucre varies considerably in the number, arrangement, and texture of its bracts, and the common receptacle varies in form and in the presence or absence of paleæ, but there are no involucels. The florets may be all alike, as in the dandelion, groundsel, and thistles, in which case they are all perfect (*homogamous*); or there may be an outer series or *ray* and an inner group or *disk*, which may have their corollas similarly coloured (*homochromous*) or differing (*heterochromous*); besides which they will commonly be *heterogamous*, the disk florets, that is, being either perfect or staminate, and the ray florets either pistillate or neuter. The calyx either has no limb or a pappus, which generally persists in the fruit. The corolla may be tubular, ligulate, or bilabiate, and the five stamens are epipetalous with syngenesious, introrse anthers. The one-chambered ovary has one anatropous ovule rising from its base, but lateral to the apex of the floral axis, a style simple below and bifid above, and stigmatic surfaces on the inner surface of the V-like fork. The fruit is a cypsela, sometimes with a sessile or stipitate pappus, and the seed is exalbuminous. The floral formula is (5).[(5).(5).](2̄). Opinions differ as to whether the hairs of the pappus are phyllomes, representing sepals, or trichomes. In development the petals are developed first and then the stamens, the anthers of which are at first free, and the intercalary growth carrying up the filaments on the "corolla-tube" occurs subsequently. Similarly the receptacle becomes concave and the carpels merely arch over the ovarian cavity in which the ovule originates. The order has been variously subdivided according to the form of the florets, their sexual characters, the form of the anthers, stigmas, and pappus. The simplest division is into three sub-orders:—*Tubulifloræ*, with all the florets tubular and perfect, or those of the disk so whilst those of the ray may be ligulate and pistillate or neuter—mostly bitter and aromatic plants of hot climates; *Labiatifloræ*, a small group in extratropical South America, with bilabiate corollas; and *Liguliflorœ* or *Cichoriaceæ*, most abundant in cold climates, with all the

florets ligulate and perfect, and a milky narcotic latex. To the first of these sub-orders belong the wormwoods (*Artemisia*), camomiles, *Arnica*, marigold (*Calendula*), sunflower (*Helianthus annuus*), Jerusalem artichoke (*H. tuberosus*), with edible tubers, the dye safflower (*Carthamus tinctorius*), and the globe artichoke (*Cynara Scolymus*) with succulent bases to its involucral bracts; besides chrysanthemums (*Pyrethrum sinense*, etc.), asters (*Callistemma hortense*), *Cineraria*, *Dahlia*, and everlastings (*Gnaphalium*, *Helichrysum*, etc.). The *Liguliflorae* include the lettuce (*Lactuca sativa*), chicory (*Cichorium Intybus*), endive, dandelion, etc.

The cohort *Campanales* differs from the last in not having generally a capitulate inflorescence, in the stamens not being epipetalous, and in having from two to six chambers to the ovary, each containing numerous albuminous seeds. The principal order it contains is the *Campanulaceae*, herbs with a milky juice and scattered leaves, including the bell-flowers (*Campanula*) with polysymmetric campanulate corollas, and the genus *Lobelia* with a bilabiately monosymmetric corolla, syngenesious anthers, and the whole flower inverted by a twisting of the peduncle.

ALGEBRA.—IX.

[Continued from p. 95.]

SIMPLE EQUATIONS WITH TWO UNKNOWN QUANTITIES.

195. In our former lessons on Simple Equations we gave the rules for solving those which contain only *one* unknown quantity; and, with the exception of one or two, the whole Centenary of Problems were solved by means of these rules. We proceed now to show how to resolve equations which contain *two* unknown quantities.

Cases indeed frequently occur in which *two* unknown quantities are necessarily introduced into the same calculation.

EXAMPLE.—Suppose the following equations are given, viz.:—

$$(1)\ x+y=14,$$
$$(2)\ x-y=2.$$

Here, if y be transposed in each, they will become

$$(1)\ x=14-y,$$
$$(2)\ x=2+y.$$

Now, the first member of each of the equations is x, and the second member of each is equal to x. But according to the axiom that quantities which are respectively equal to another quantity, are equal to each other; therefore we have

$$2+y=14-y;\ \text{whence}\ y=6.$$

Lastly, by substituting the value of y in the first equation, we have $x+6=14$; and $x=8$. Therefore, 8 and 6 are the values of x and y.

196. In solving the preceding problem, it will be observed that we first found the value of the unknown quantity x in each equation; and then, by making one of the expressions denoting the value of x equal to the other, we formed a new equation, which contained only the other unknown quantity y. This process is called *extermination* or *elimination*.

In the resolution of equations there are three methods of extermination, viz., by comparison, by substitution, and by addition and subtraction.

197. CASE I.—To exterminate one of the two unknown quantities by comparison.

RULE.—*Find the value of one of the unknown quantities in each of the equations, and form a new equation by making one of these values equal to the other. Find the value of the unknown quantity in this equation, by the rules formerly given. Then substitute this value of the one unknown quantity in either of the other equations, and resolving it by the same rules, the other unknown quantity will be found.*

EXAMPLE.—Given $x+y=36$, and $x-y=12$; to find the values of x and y.

	Gives
Transposing y in the first equation,	$x=36-y.$
Transposing y in the second equation,	$x=12+y.$
Making these values of x equal,	$12+y=36-y.$
Transposing, etc.,	$y=12.$
Substituting the value of y,	$x=12+12=24.$

Hence, 24 and 12 are the values required.

EXERCISE 86.

1. Given $2x+3y=28$, and $3x+2y=27$; to find the values of x and y.
2. Given $4x+y=43$, and $3x+2y=56$; to find the values of x and y.
3. Given $4x-2y=16$, and $6x=9y$; to find the values of x and y.
4. Given $4x-2y=20$, and $4x+2y=100$; to find the values of x and y.
5. Given $5x+8=7y$, and $5y+32=7x$; to find the values of x and y.

EXAMPLE (1).—To find two numbers such that their sum shall be 24; and the greater shall be equal to five times the less.

Here, let x be the greater, and y the less.

Then, $x+y=24$,
And $x=5y$.
Whence, $5y+y=6y=24$,
And $y=4$;
Therefore, $x=20$. *Ans.* 20 and 4.

EXAMPLE (2).—Find two quantities whose sum is equal to h; and the difference of whose squares is equal to d.

Let x and y be the two quantities.

$$\left.\begin{array}{l}\text{Then}\ x+y=h\\ \text{And}\ \ x^2-y^2=d\end{array}\right\}\ \text{per question.}$$

From the first equation we have, by transposition,

$$x = h - y,$$

And, by squaring both sides, we have,

$$x^2 = h^2 - 2hy + y^2.$$

From the escond equation we have, by transposition,

$$x^2 = y^2 + d.$$

Now, by equating the two values of x^2, we have,

$$y^2 + d = h^2 - 2hy + y^2;$$

And, by transposition and cancelling, we have,

$$2hy = h^2 - d;$$

$$\text{Whence,} \quad y = \frac{h^2 - d}{2h}.$$

$$\text{Therefore } x = h - \frac{h^2 - d}{2h} = \frac{h^2 + d}{2h}.$$

EXAMPLE (3).—Given $ax + by = h$, and $x + y = d$; to find the values of x and y.

Here, from the first equation, we have, by transposition,

$$ax = h - by,$$

$$\text{And } x = \frac{h - by}{a}.$$

Again, from the second equation, we have, by transposition,

$$x = d - y,$$

$$\text{Whence, } \frac{h - by}{a} = d - y;$$

$$\text{Or,} \quad h - by = ad - ay,$$

$$\text{And} \quad ay - by = ad - h.$$

From this equation, by separating the left-hand member into factors, we have

$$(a - b)\, y = ad - h;$$

$$\text{Whence,} \quad y = \frac{ad - h}{a - b};$$

$$\text{Consequently, } x = d - \frac{ad - h}{a - b} = \frac{h - bd}{a - b}$$

The rule given above may be generally applied for the extermination of unknown quantities. But there are cases in which other methods will be found more expeditious.

EXAMPLE (4).—Given $x = hy$, and $ax + bx = y^2$; to find the values of x and y.

As in the first of these equations x is equal to hy, we may in the second equation *substitute* this value of x for x itself. The second equation will then become, $ahy + bhy = y^2$.

The equality of the two sides is not affected by this alteration, because we only change one quantity x for another which is equal to it. By this means we obtain an equation which contains only one unknown quantity. Whence, $y = ah + bh$, and $x = ah^2 + bh^2$.

This process is called *extermination by substitution.*

198. CASE II.—To exterminate an unknown quantity by substitution.

RULE.—*Find the value of one of the unknown quantities, in one of the equations, in terms of the other unknown; and then in the other equation* SUBSTITUTE *this value for the former unknown quantity. From this equation, find the value of this unknown quantity, as before.*

EXAMPLE (5).—Given $x + 3y = 15$; and $4x + 5y = 32$; to find the values of x and y.

Here, transposing $3y$ in the first equation, we have,

$$x = 15 - 3y.$$

Substituting the value of x in the second equation, we have,

$$60 - 12y + 5y = 32;$$

Whence, by transposition, etc.,

$$y = 4.$$

And, from the first equation,

$$x = 15 - 12 = 3.$$

There is a *third* method of exterminating an unknown quantity from an equation, which, in many cases, is preferable to either of the preceding.

EXAMPLE (6).—Given $x + 3y = a$, and $x - 3y = b$; to find the values of x and y.

Here, if we *add together* the first members of these two equations, and also the second members, we shall have,

$$2x = a + b,$$

an equation which contains only the unknown quantity x. The other, having equal coefficients with contrary signs, has disappeared. Still the equality of the sides is preserved, because we have only added equal quantities to equal quantities.

$$\text{Whence } x = \frac{a + b}{2},$$

$$\text{And} \quad y = \frac{a - x}{3} = \frac{a - b}{6}.$$

EXAMPLE (7).—Given $3x + y = h$, and $2x + y = d$; to find the values of x and y.

Here, if we *subtract* the second equation from the first, we shall have $x = h - d$, where y is exterminated, without affecting the equality of the sides. Whence, $y = 3d - 2h$.

EXAMPLE (8).—Given $x - 2y = a$, and $x + 4y = b$; to find the values of x and y.

Here, multiplying the first equation by 2, we have,

$$2x - 4y = 2a;$$

Then, adding the second and third equations, we have,

$$3x = b + 2a;$$

$$\text{Whence, } x = \tfrac{1}{3}(b + 2a),$$

$$\text{And} \quad y = \tfrac{1}{6}(b - a).$$

This process is called *extermination by addition and subtraction.*

EXERCISE 37

1. Given $8x + y = 42$, and $2x + 4y = 18$, to find the values of x and y.

2. Given $2x + 8y = 64$, and $4x + 6y = 68$; to find the values of x and y.

3. Given $3x + 3y = 72$, and $4x + 5y = 116$; to find the values of x and y.

4. Given $\frac{1}{2}x + 10y = 124$, and $2x + 9y = 121$; to find the values of x and y.

5. A privateer in chase of a ship 20 miles distant sails 8 miles, whilst the ship sails 7. How far will each sail before the privateer will overtake the ship?

6. The ages of two persons, A and B, are such that seven years ago A was three times as old as B; and seven years hence, A will be twice as old as B. What is the age of each?

7. There are two numbers, of which the greater is to the less as 3 to 2; and their sum is the sixth part of their product. What are the numbers?

199. CASE III.—To exterminate an unknown quantity by addition and subtraction.

RULE.—*Multiply or divide the equations, if necessary, by such factors that the term which contains one of the unknown quantities shall be the same in both equations. Then subtract one equation from the other, if the signs of this unknown quantity are alike, or add them together if the signs are unlike; the result will be an equation containing only one unknown quantity, which is to be resolved as before.*

It must be kept in mind that both members of an equation are always to be increased or diminished alike, in order to preserve their equality.

EXAMPLE (9).—Given $2x + 4y = 20$, and $4x + 5y = 28$; to find the values of x and y.

Here, multiplying the first equation by 2, we have,

$$4x + 8y = 40.$$

Subtracting the second equation from this, we have,

$$3y = 12;$$

$$\text{Whence, } y = 4, \text{ and } x = 2.$$

In the solution of the succeeding problems, either of the three rules for exterminating unknown quantities may be used at pleasure. *That quantity which is the least involved should be the one chosen to be first exterminated.*

The student will find it a useful exercise to solve every example by *each* of the separate methods, and carefully to observe which is the most comprehensive, and the best adapted to different classes of problems.

EXAMPLE (10).—To find a fraction such that, if a unit be added to the numerator, the fraction will be equal to $\frac{1}{3}$; but if a unit be added to the denominator, the fraction will be equal to $\frac{1}{4}$.

Let x = the numerator, and y = the denominator.

Here, by the first condition, we have $\dfrac{x+1}{y} = \dfrac{1}{3}$;

And by the second, we have $\dfrac{x}{y+1} = \dfrac{1}{4}$.

Whence, $x = 4$, the numerator;

And $y = 15$, the denominator.

Therefore, $\frac{4}{15}$ is the required fraction.

EXERCISE 38.

1. Given $2x + y = 16$, and $3x - 3y = 6$; to find the values of x and y.

2. Given $4x + 3y = 50$, and $3x - 3y = 6$; to find the values of x and y.

3. Given $3x + y = 38$, and $5x + 4y = 68$; to find the values of x and y.

4. Given $4x - 40 = -4y$, and $6x - 63 = -7y$; to find the values of x and y.

5. The numbers of two opposing armies are such, that the sum of both is 21,110; and twice the number in the greater army, added to three times the number in the less, is 52,219. What is the number in each army?

6. The sum of two numbers is 220, and if three times the less be taken from four times the greater, the remainder will be 180. What are the numbers?

7. The mast of a ship consists of two parts; one-third of the lower part added to one-sixth of the upper part is equal to 28 feet, and five times the lower part diminished by six times the upper part is equal to 12 feet. What is the height of the mast?

8. What two numbers are these, whose difference is to their sum as 2 to 3; and whose sum is to their product as 3 to 5?

9. To find two numbers such that the product of their sum and difference shall be 5, and the product of the sum of their squares and the difference of their squares shall be 65.

10. To find two numbers whose sum is 32, and whose product is 240.

11. To find two numbers whose sum is 52, and the sum of their squares 1,424.

12. A certain number consists of two digits or figures, the sum of which is 8. If 36 be added to the number, the digits will be inverted. What is the number?

13. The united ages of A and B amount to a certain number of years, consisting of two digits, the sum of which is 9. If 27 years be subtracted from the amount of their ages, the digits will be inverted. What is the sum of their ages?

14. A merchant having mixed a quantity of brandy and gin, found if he had put in 6 gallons more of each, the compound would have contained 7 gallons of brandy for every 6 of gin; but if he had put in 6 gallons less of each, the proportions would have been as 6 to 5. How many gallons did he mix of each?

SIMPLE EQUATIONS WITH THREE UNKNOWN QUANTITIES.

200. In the preceding examples of two unknown quantities, it will be perceived that the conditions of each problem have furnished two equations independent of each other. It often becomes necessary to introduce *three* or *more* unknown quantities into a calculation. In such cases, if the problem admits of a determinate answer, there will always arise from the conditions as many equations *independent* of each other as there are unknown quantities.

Equations are said to be *independent* when they express *different* conditions.

They are said to be *dependent* when they express

the *same* conditions under *different* forms. The former are not convertible into each other; but the latter may be changed from one form into the other. Thus $b - x = y$; and $b = y + x$, are dependent equations, because one is formed from the other by merely transposing x. Equations are said to be identical when they express the same thing in the same form expressed or implied; as $4x - 6 = 4x - 6$, or $2(2x - 3) = 4x - 6$.

EXAMPLE (1).—Given $x + y + z = 12$, $x + 2y - 2z = 10$, and $x + y - z = 4$; to find the values of x, y, and z.

From these three equations, two others may be derived which shall contain only *two* unknown quantities. One of the three unknown quantities in the original equations may be exterminated, in the same manner as when there are at first only two, by the rules already given. Thus, if in the equations given above we transpose y and z, we shall have,

From the first, $x = 12 - y - z$;
From the second, $x = 10 - 2y + 2z$;
From the third, $x = 4 - y + z$.

From these we may now deduce two new equations, from which x shall be excluded.

By making the first and second equal, we have

$$12 - y - z = 10 - 2y + 2z.$$

By making the second and third equal, we have

$$10 - 2y + 2z = 4 - y + z.$$

Reducing the first of these two, we have

$$y = 3z - 2.$$

Reducing the second, we have

$$y = z + 6.$$

From these two equations one may be derived containing only *one* unknown quantity.

By making the one equal to the other, we have

$$3z - 2 = z + 6.$$

Therefore, $z = 4$. Hence, $y = 10$, and $x = -2$.

201. To solve a problem containing *three* unknown quantities, and producing three independent equations.

RULE.—*First, from the three equations deduce two, containing only two unknown quantities. Then, from these two deduce one, containing only one unknown quantity. Lastly, find the values of the other unknown quantities as before.*

For making these deductions, the rules already given are sufficient.

EXAMPLE (2).—Given $x + 5y + 6z = 53$, $x + 3y + 3z = 30$, and $x + y + z = 12$; to find the values of x, y, and z.

Here, from these three equations, in order to derive two containing only two unknown quantities,

Subtracting the second from the first, we have

$$2y + 3z = 23; \quad \text{(the fourth equation)}$$

Subtracting the third from the second, we have

$$2y + 2z = 18. \quad \text{(the fifth equation)}$$

Next, from these two, in order to derive one,
Subtracting the fifth from the fourth, we have

$$= 5.$$

To find x and y, we have only to take their values from the third and fifth equations.

Reducing the fifth, we have

$$y = 9 - z = 9 - 5 = 4.$$

Transposing in the third, we have

$$x = 12 - z - y = 12 - 5 - 4 = 3.$$

In many of the examples in the preceding lessons, the processes might have been shortened. But the object was to illustrate *general* principles, rather than to furnish specimens of *expeditious* solutions. The learner will do well, as he passes along, to exercise his skill in abridging the calculations here given, or substituting others in their stead.

He must also exercise his own judgment as to the choice of the quantity to be first exterminated. It will generally be best to begin with that which is most free from *coefficients, fractions, radical signs,* etc.—that is, the quantity least involved.

EXERCISE 39.

1. Given $x + y + z = 12$, $x + 2y + 3z = 20$, and $\frac{1}{3}x + \frac{1}{2}y + z = 6$; to find the values of x, y, and z.

2. Given $x + y = a$, $x + z = b$, and $y + z = c$; to find the values of x, y, and z.

3. Three persons, A, B, and C, purchase a horse for 100 dollars, but neither is able to pay for the whole. The payment would require the whole of A's money, together with half of B's; or the whole of B's with one-third of C's; or the whole of C's, with one-fourth of A's. How much money has each?

4. The sum of the distances which three persons, A, B, and C, have travelled, is 62 miles; A's distance is equal to four times C's added to twice B's; and twice A's added to three times B's, is equal to 17 times C's. What are the respective distances?

5. Given $\frac{1}{2}x + \frac{1}{3}y + \frac{1}{4}z = 62$, $\frac{1}{3}x + \frac{1}{4}y + \frac{1}{5}z = 47$, and $\frac{1}{4}x + \frac{1}{5}y + \frac{1}{6}z = 38$; to find the values of x, y, and z.

6. Given $xy = 600$, $xz = 300$, and $yz = 200$; to find the values of x, y, and z.

SIMPLE EQUATIONS WITH FOUR OR MORE UNKNOWN QUANTITIES.

202. The same method which is employed for the reduction of three equations may be extended to *four* or *five*, or any number of equations, containing *as many* unknown quantities.

The unknown quantities may be exterminated, one after another, and the number of equations may be reduced by successive steps from *five* to *four*, from *four* to *three*, from *three* to *two*, and so on to *one*.

EXAMPLE (1).—

Given $\frac{1}{2}y + z + \frac{1}{2}w = 8$, (1)

$x + y + w = 9$. (2)

$x + y + z = 12$. (3)

$x + w + z = 10$; (4)

to find the values of w, x, y, and z.

Here, clearing the first equation of fractions, we have

$y + 2z + w = 16$; (5)

Subtracting the second from the third, we have

$z - w = 3$; (6)

Subtracting the fourth from the third, we have

$y - w = 2$. (7)

Next, adding the fifth and the sixth, we have

$y + 3z = 19$; (8)

Subtracting the seventh from the sixth, we have

$-y + z = 1$. (9)

Again, adding the eighth and the ninth, we have

$4z = 20$, or $z = 5$;

Transposing in the eighth, we have

$y = 19 - 3z = 4$;

Transposing in the third, we have

$x = 12 - y - z = 3$;

Transposing in the second, we have

$w = 9 - x - y = 2$.

EXAMPLE (2).—

Given $w + 50 = x$,

$x + 120 = 3y$,

$y + 120 = 2z$,

$z + 195 = 3w$;

to find the values of w, x, y, and z. *Ans.* $w = 100$, $x = 150$, $y = 90$, and $z = 105$.

EXERCISE 40.

1. There is a certain fraction, such, that if 3 be added to the numerator, the value of the fraction will be $\frac{1}{3}$; but if 1 be subtracted from the denominator, the value will be $\frac{1}{4}$. What is the fraction?

2. Divide the number 90 into four such parts, that if the first is *increased* by 2, the second *diminished* by 2, the third *multiplied* by 2, and the fourth *divided* by 2, shall all be equal.

3. Find three numbers, such that the *first*, with half the sum of the *second* and *third*, shall be 120; the *second*, with $\frac{1}{3}$ the difference of the *third* and *first*, shall be 70; and half the sum of the three numbers shall be 95.

4. What fraction is that, whose numerator being doubled, and the denominator increased by 7, the value becomes $\frac{2}{3}$; but the denominator being doubled, and the numerator increased by 2, the value becomes $\frac{3}{5}$?

KEY TO EXERCISES.

EXERCISE 31.

1. $27x^3$.	7. $64b^3$.	13. $(a+b)^{10}$.
2. $256y^4$.	8. $0^n a^n d^n$.	14. $(a+b)^{3n}$.
3 $128n^7$.	9. $216m^3y^3$.	15. $(x-y)^{mn}$.
4. $b^3m^3x^3$.	10. $a^{12}l^8$.	16. $(x+y)^{2n}$.
5. $a^n d^n y^n$.	11. $64a^6x^3$.	17. a^6b^6.
6. $d^4h^4y^4$	12. $1296a^{12}x^8d^4$.	18. $a^9b^6h^{12}$.

EXERCISE 32

1. $\frac{1}{x^2}, \frac{1}{a^3}, \frac{1}{a^4}$.
2. $\frac{8x^7r^6}{27l^3}$.
3. $\frac{x^{2n}r^n}{a^ny^{mn}}$.
4. $\frac{n^6(d-x)^2}{(x+1)^4}$.
5. $a^2 - 2ab + b^2$.
6. $a^4 + [illegible] - 2a + 1$.
7. $a^2 + 2ab - 2ad - [illegible] + 2bh + h^2$
8. $a^2 + 4ad + [illegible] - 4d^2 + 12d - 9$.
9. $b^4 - 8b^3 + 24b^2 - 32b + 16$.
10. $x^5 - 5x^4 + 10x^3 + 10x^2 + 5x + 1$
11. $1 - 6b - 15b^2 - 20b^3 + 15b^4 - 6b^5 + 6b^6$.

EXERCISE 33.

1. $4a^2 + b^2 + 4ab$.
2. $h^2 + 1 + 2h$.
3. $a^2b^2 + c^2d^2 + 2abcd$
4. $36y^2 + 9 + 36y$.
5. $9l^4 + h^2 - 6l^2h$.
6. $a^2 + 1 - 2a$.

EXERCISE 34.

1. $d^5 + 5d^4h + 10d^3h^2 + 10d^2h^3 + 5dh^4 + h^5$.

2. $b^n + Ab^{n-1}y + Bb^{n-2}y^2 + Cb^{n-3}y^3 + Db^{n-4}y^4 +$ etc. in which the coefficients which are here represented by A, B, and C, etc., are respectively n, $n.\frac{n-1}{2}$, $n.\frac{n-1}{2}.\frac{n-2}{3}$, etc.

3. $729x^6 + 2916x^5y + 4860x^4y^2 + 4320x^3y^3 + 2160x^2y^4 + 576xy^5 + 64y^6$.

4. $a^2 - 2ab + b^2$.

5 $a^3 - 3a^2b + 3ab^2 - b^3$.

6. $a^4 - 4a^3b + 6a^2b^2 - 4ab^3 + b^4$.

7. $x^6 - 6x^5y + 15x^4y^2 - 20x^3y^3 + 15x^2y^4 - 6xy^5 + y^6$.

8. $a^n - na^{n-1}b + n\frac{n-1}{2}a^{n-2}b^2 - n\frac{n-1}{2}\frac{n-2}{3}a^{n-3}b^3 +$, etc.

9. $a^4 - 4a^3 + 6a^2 + 6a + 1$.

10. $1 - 6y + 15y^2 - 20y^3 + 15y^4 - 6y^5 + y^6$.

11. $1 + nx + n.\frac{n-1}{2}x^2 +$, etc.

12. $a^2 + \frac{4}{3}a + \frac{4}{9}$

13. $x^2 - bx + \frac{b^2}{4}$

14. $\frac{b^2}{m^2} - \frac{6bxy}{m} + 9x^2y^2$.

15. $\frac{36}{49} - \frac{24}{7}abc + 4a^2b^2c^2$.

EXERCISE 35.

1. $x^3 + 3x^2y + 3xy^2 + y^3$
2. $a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$.
3. $a^6 - 6a^5b + 15a^4b^2 - 20a^3b^3 + 15a^2b^4 - 6ab^5 + b^6$.
4. $x^5 + 5x^4y + 10x^3y^2 + 10x^2y^3 + 5xy^4 + y^5$.
5. $x^8 - 8x^7y + 28x^6y^2 - 56x^5y^3 + 70x^4y^4 - 56x^3y^5 + 28x^2y^6 - 8xy^7 + y^8$.
6. $m^7 + 7m^6n + 21m^5n^2 + 35m^4n^3 + 35m^3n^4 + 21m^2n^5 + 7mn^6 + n^7$.
7. $a^9 + 9a^8b + 36a^7b^2 + 84a^6b^3 + 126a^5b^4 + 126a^4b^5 + 84a^3b^6 + 36a^2b^7 + 9ab^8 + b^9$.
8. $x^{10} + 10x^9y + 45x^8y^2 + 120x^7y^3 + 210x^6y^4 + 252x^5y^5 + 210x^4y^6 + 120x^3y^7 + 45x^2y^8 + 10xy^9 + y^{10}$.
9. $x^{13} - 13x^{12}y + 78x^{11}y^2 - 286x^{10}y^3 + 715x^9y^4 - 1287x^8y^5 + 1716x^7y^6 - 1716x^6y^7 + 1287x^5y^8 - 715x^4y^9 + 286x^3y^{10} - 78x^2y^{11} + 13xy^{12} - y^{13}$.
10. $a^7 - 7a^6b + 21a^5b^2 - 35a^4b^3 + 35a^3b^4 - 21a^2b^5 + 7ab^6 - b^7$.
11. $a^8 + 8a^7b + 28a^6b^2 + 56a^5b^3 + 70a^4b^4 + 56a^3b^5 + 28a^2b^6 + 8ab^7 + b^8$.
12. $32 + 80x + 80x^2 + 40x^3 + 10x^4 - x^5$.
13. $a^3 - 3a^2bx + 3a^2c + 3ab^2x^2 - 6abcx + 3ac^2 - b^3x^3 + 3b^2cx^2 - 3bc^2x + c^3$
14. $a^3 + 9a^2bc + 27ab^2c^2 + 27b^3c^3$.
15. $16a^4b^4 - 32a^3b^3x + 24a^2b^2x^2 - 8abx^3 + x^4$.
16. $16a^2b^2 + 40abc^2 + 25c^4$.
17. $27x^3 + 162x^2y - 324xy^2 - 216y^3$.
18. $125a^3 + 225a^2d + 135ad^2 + 27d^3$.

FRENCH.—XXVII.

[Continued from p. 102.]

ALPHABETICAL TABLE

OF THE IRREGULAR, DEFECTIVE, PECULIAR, AND IMPERSONAL VERBS (continued).

The figures placed after the infinitive of the verbs indicate the conjugations to which they belong.—The tenses not given in this Table are not used.

Infinitive.	Participles.	Indicative: Present.	Indicative: Imperfect.	Indicative: Past Definite.	Indicative: Future.	Conditional Present.	Imperative.	Subjunctive: Present.	Subjunctive: Imperfect.
SOURIRE, 4, *to smile*	souriant souri	je souris *see* RIRE	je souriais	je souris	je sourirai	je sourirais	souris	je sourie	je sourisse
SOUSCRIRE, 4, *to subscribe*	souscrivant souscrit, *f.* -e	je souscris *see* ÉCRIRE	je souscrivais	je souscrivis	je souscrirai	je souscrirais	souscris	je souscrive	je souscrivisse
SOUSTRAIRE, 4, *to subtract*	soustrayant soustrait, *f.* -e	je soustrais *see* TRAIRE	je soustrayais		je soustrairai	je soustrairais	soustrais	je soustraie	
SOUTENIR, 2, *to sustain*	soutenant soutenu, *f.* -e	je soutiens *see* TENIR	je soutenais	je soutins	je soutiendrai	je soutiendrais	soutiens	je soutienne	je soutinsse
SOUVENIR (SE), 2, *to remember*	se souvenant souvenu, *f.* -e	je me souviens *see* TENIR	je me souvenais	je me souvins	je me souviendrai	je me souviendrais	souviens-toi	je me souvienne	je me souvinsse
SUBVENIR, 2, *to relieve*	subvenant subvenu, *f.* -e	je subviens *see* TENIR	je subvenais	je subvins	je subviendrai	je subviendrais	subviens	je subvienne	subvinsse
SUFFIRE, 4, *to suffice* aux. avoir irregular	suffisant suffi	je suffis tu suffis il suffit n. suffisons v. suffisez ils suffisent	je suffisais tu suffisais il suffisait n. suffisions v. suffisiez ils suffisaient	je suffis tu suffis il suffit n. suffîmes v. suffîtes ils suffirent	je suffirai tu suffiras il suffira n. suffirons v. suffirez ils suffiront	je suffirais tu suffirais il suffirait n. suffirions v. suffiriez ils suffiraient	suffis qu'il suffise suffisons suffisez q. i. suffisent	je suffise tu suffises il suffise n. suffisions v. suffisiez ils suffisent	je suffisse tu suffisses il suffît n. suffissions v. suffissiez ils suffissent
SUIVRE, 4, *to follow* aux. avoir irregular	suivant suivi, *f.* -e	je suis tu suis il suit n. suivons v. suivez ils suivent	je suivais tu suivais il suivait n. suivions v. suiviez ils suivaient	je suivis tu suivis il suivit n. suivîmes v. suivîtes ils suivirent	je suivrai tu suivras il suivra n. suivrons v. suivrez ils suivront	je suivrais tu suivrais il suivrait n. suivrions v. suivriez ils suivraient	suis qu'il suive suivons suivez q. i. suivent	je suive tu suives il suive n. suivions v. suiviez ils suivent	je suivisse tu suivisses il suivît n. suivissions v. suivissiez ils suivissent
SURFAIRE, 4, *to overcharge*	surfaisant surfait, *f.* -e	je surfais *see* FAIRE	je surfaisais	je surfis	je surferai	je surferais	surfais	je surfasse	je surfisse
SURPRENDRE, 4, *to surprise*	surprenant surpris, *f.* -e	je surprends *see* PRENDRE	je surprenais	je surpris	je surprendrai	je surprendrais	surprends	je surprenne	je surprisse
SURSEOIR, 3, *to put off, to postpone* aux. avoir	sursoyant sursis	je sursois tu sursois il sursoit n. sursoyons v. sursoyez ils sursoient	je sursoyais tu sursoyais il sursoyait n. sursoyions v. sursoyiez ils sursoyaient	je sursis tu sursis il sursit n. sursîmes v. sursîtes ils sursirent	je surseoirai tu surseoiras il surseoira n. surseoirons v. surseoirez ils surseoiront	je surseoirais tu surseoirais il surseoirait n. surseoirions v. surseoiriez i. surseoiraient	sursois qu'il sursoie sursoyons sursoyez q. i. sursoient	je sursoie tu sursoies il sursoie n. sursoyions v. sursoyiez ils sursoient	je sursisse tu sursisses il sursît n. sursissions v. sursissiez ils sursissent
SURVENIR, 2, *to happen, etc.*	survenant survenu, *f.* -e	je surviens *see* TENIR	je survenais	je survins	je surviendrai	je surviendrais	surviens	je survienne	je survinsse
SURVIVRE, 4, *to survive*	survivant survécu	je survis *see* VIVRE	je survivais	je survécus	je survivrai	je survivrais	survis	je survive	je survécusse
TAIRE (SE), 4, *to be silent*	se taisant tu, *f.* -e	je me tais *see* PLAIRE	je me taisais	je me tus	je me tairai	je me tairais	tais-toi	je me taise	je me tusse
TEINDRE, 4, *to dye*	teignant teint, *f.* -e	je teins *see* CRAINDRE	je teignais	je teignis	je teindrai	je teindrais	teins	je teigne	je teignisse

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TENIR, 2, *to hold* aux. avoir irregular	tenant tenu, *f.* -e	je tiens tu tiens il tient n. tenons v. tenez ils tiennent	je tenais tu tenais il tenait n. tenions v. teniez ils tenaient	je tins tu tins il tint n. tînmes v. tîntes ils tinrent	je tiendrai tu tiendras il tiendra n. tiendrons v. tiendrez ils tiendront	je tiendrais tu tiendrais il tiendrait n. tiendrions v. tiendriez ils tiendraient	tiens qu'il tienne tenons tenez q. i. tiennent	je tienne tu tiennes il tienne n. tenions v. teniez ils tiennent	je tinsse tu tinsses il tînt n. tinssions v. tinssiez ils tinssent
TONNER, 1, *to thunder*, imp.	tonnant tonné	il tonne	il tonnait	il tonna	il tonnera	il tonnerait		qu'il tonne	qu'il tonnât
TRADUIRE, 4, *to translate*	traduisant traduit, *f.* -e	je traduis see CONDUIRE	je traduisais	je traduisis	je traduirai	je traduirais	traduis	je traduise	je traduisisse
TRAIRE, 4, *to milk* aux. avoir defective	trayant trait, *f.* -e	je trais tu trais il trait n. trayons v. trayez ils traient	je trayais tu trayais il trayait n. trayions v. trayiez ils trayaient		je trairai tu trairas il traira n. trairons v. trairez ils trairont	je trairais tu trairais il trairait n. trairions v. trairiez ils trairaient	trais qu'il traie trayons trayez qu'ils traient	je traie tu traies il traie n. trayions v. trayiez ils traient	
TRANSCRIRE, 4, *to transcribe*	transcrivant transcrit, *f.* -e	je transcris see ÉCRIRE	je transcrivais	je transcrivis	je transcrirai	je transcrirais	transcris	je transcrive	je transcrivisse
TRANSMETTRE, 4, *to transmit*	transmettant transmis, *f.* -e	je transmets see METTRE	je transmettais	je transmis	je transmettrai	je transmettrais	transmets	je transmette	je transmisse
TRESSAILLIR, 2, *to start*	tressaillant tressailli	je tressaille see ASSAILLIR	je tressaillais	je tressaillis	je tressaillirai	je tressaillirais	tressaille	je tressaille	je tressaillisse
VAINCRE, 4, *to vanquish* aux. avoir irregular	vainquant vaincu, *f.* -e	je vaincs tu vaincs il vainc n. vainquons v. vainquez ils vainquent	je vainquais tu vainquais il vainquait n. vainquions v. vainquiez ils vainquaient	je vainquis tu vainquis il vainquit n. vainquîmes v. vainquîtes ils vainquirent	je vaincrai tu vaincras il vaincra n. vaincrons v. vaincrez ils vaincront	je vaincrais tu vaincrais il vaincrait n. vaincrions v. vaincriez ils vaincraient	vaincs qu'il vainque vainquons vainquez q. i. vainquent	je vainque tu vainques il vainque n. vainquions v. vainquiez ils vainquent	je vainquisse tu vainquisses il vainquît n. vainquissions v. vainquissiez i. vainquissent
VALOIR, 3, *to be worth* aux. avoir irregular	valant valu	je vaux tu vaux il vaut n. valons v. valez ils valent	je valais tu valais il valait n. valions v. valiez ils valaient	je valus tu valus il valut n. valûmes v. valûtes ils valurent	je vaudrai tu vaudras il vaudra n. vaudrons v. vaudrez ils vaudront	je vaudrais tu vaudrais il vaudrait n. vaudrions v. vaudriez ils vaudraient	vaux qu'il vaille valons valez q. i. vaillent	je vaille tu vailles il vaille n. valions v. valiez ils vaillent	je valusse tu valusses il valût n. valussions v. valussiez ils valussent
VENIR, 2, *to come*, aux. être	venant venu, *f.* -e	je viens see TENIR	je venais	je vins	je viendrai	je viendrais	viens	je vienne	je vinsse
VÊTIR, 2, *to clothe* aux. avoir irregular	vêtant vêtu, *f.* -e	je vêts tu vêts il vêt n. vêtons v. vêtez ils vêtent	je vêtais tu vêtais il vêtait n. vêtions v. vêtiez ils vêtaient	je vêtis tu vêtis il vêtit n. vêtîmes v. vêtîtes ils vêtirent	je vêtirai tu vêtiras il vêtira n. vêtirons v. vêtirez ils vêtiront	je vêtirais tu vêtirais il vêtirait n. vêtirions v. vêtiriez ils vêtiraient	vêts qu'il vête vêtons vêtez qu'ils vêtent	je vête tu vêtes il vête n. vêtions v. vêtiez ils vêtent	je vêtisse tu vêtisses il vêtît n. vêtissions v. vêtissiez ils vêtissent
VIVRE, 4, *to live* aux. avoir irregular	vivant vécu	je vis tu vis il vit n. vivons v. vivez ils vivent	je vivais tu vivais il vivait n. vivions v. viviez ils vivaient	je vécus tu vécus il vécut n. vécûmes v. vécûtes ils vécurent	je vivrai tu vivras il vivra n. vivrons v. vivrez ils vivront	je vivrais tu vivrais il vivrait n. vivrions v. vivriez ils vivraient	vis qu'il vive vivons vivez qu'ils vivent	je vive tu vives il vive n. vivions v. viviez ils vivent	je vécusse tu vécusses il vécût n. vécussions v. vécussiez ils vécussent
VOIR, 3, *to see* aux. avoir irregular	voyant vu, *f.* -e	je vois tu vois il voit n. voyons v. voyez ils voient	je voyais tu voyais il voyait n. voyions v. voyiez ils voyaient	je vis tu vis il vit n. vîmes v. vîtes ils virent	je verrai tu verras il verra n. verrons v. verrez ils verront	je verrais tu verrais il verrait n. verrions v. verriez ils verraient	vois qu'il voie voyons voyez qu'ils voient	je voie tu voies il voie n. voyions v. voyiez ils voient	je visse tu visses il vît n. vissions v. vissiez ils vissent
VOULOIR, 3, *to be willing* aux. avoir irregular	voulant voulu	je veux tu veux il veut n. voulons v. voulez ils veulent	je voulais tu voulais il voulait n. voulions v. vouliez ils voulaient	je voulus tu voulus il voulut n. voulûmes v. voulûtes ils voulurent	je voudrai tu voudras il voudra n. voudrons v. voudrez ils voudront	je voudrais tu voudrais il voudrait n. voudrions v. voudriez ils voudraient	veuillez	je veuille tu veuilles il veuille n. voulions v. vouliez ils veuillent	je voulusse tu voulusses il voulût n. voulussions v. voulussiez ils voulussent

THE SYNTAX OF THE VERB.—AGREEMENT OF THE VERB WITH ITS SUBJECT.

The verb agrees with its subject, whether such subject precedes or follows:—

L'homme est né pour régner sur tous les animaux. VOLTAIRE.	*Man is born to reign over all animals.*
Les hommes sont encore enfants à soixante ans. AUBERT.	*Men are still children at sixty.*
Par ces portes sortaient les fières légions. SAINT VICTOR.	*Through those gates issued the proud legions.*

When a verb has two or more subjects connected by the conjunction *et*, the verb is put in the plural, whether or not all the subjects are in the singular:—

La colère et la précipitation sont deux choses fort opposées à la prudence. FÉNELON.	*Anger and precipitation are two things very much opposed to prudence.*
La violence et la vertu ne peuvent rien l'une sur l'autre. PASCAL.	*Violence and virtue have no power over each other.*

When a verb has several subjects in the singular not connected by *et*, it is put in the singular or in the plural according to circumstances:—

1. It is put in the singular if the subjects are in some way synonymous:—

La douceur, la bonté du grand Henri, a été célébrée de mille louanges. PÉLISSON.	*The mildness, the goodness of the great Henry, has been celebrated by a thousand praises.*
D'où peut venir cet ennui, ce dégoût? FOUIS D'HARLEVILLE.	*Whence can proceed that weariness, that disgust?*

2. When, in a series of subjects, the last has more force or interest attached to it, and therefore makes us, as it were, overlook the others:—

Ce sacrifice — votre intérêt, votre honneur, Dieu vous le commande!	*This sacrifice — your interest, your honour, God commands it!*

3. The verb is put in the plural when the affirmation is intended to be made of all the subjects taken collectively, and not of each in particular:—

La douceur, le soupir de cette femme infortunée ne purent le fléchir.	*The sweetness, the sigh of that unfortunate woman could not move him.*
Savez-vous, si demain, Sa liberté, sa vie, seront en votre main?	*— Do you know if to-morrow, his liberty, his life, will be in your power?*

When a verb has for subjects several nouns, or nouns and pronouns of the third person, or only pronouns of that person, connected by the conjunction *ou*, the verb agrees only with the last:—

Mon frère ou mon oncle vous écrira.	*My brother or my uncle will write to you.*
Votre sœur ou lui l'a dit.	*Your sister or he has said it.*
Leur frère ou elles y étaient.	*Their brother or they were there.*
Le roi ou ses généraux l'ont ordonné.	*The king or his generals have ordered it.*

When a verb has for subjects one or several nouns and one or several pronouns of different persons, or only several pronouns of different persons, connected by the conjunction *ou*, the verb is put in the first person plural if there is a pronoun of that person among the subjects; and in the second person plural if there is among the subjects one of that person and none of the first:—

Toi ou lui avez tort.	*Thou or he are wrong.*
Mon frère, elle ou moi le ferons.	*My brother, she, or I will do it.*
Son frère, sa sœur ou toi l'avez dit.	*My brother, his sister, or thou have said it.*

When the several subjects of a verb are connected by the conjunction *ni*, the verb may be used in the plural according to the rules given in the last paragraph, or in the singular; except, however, when the action can be performed only by one subject, in which case the verb must be used in the singular:—

Ni l'un ni l'autre ne sont honnêtes.	*Neither are honest*
Ni le général ni l'ambassadeur ne vint.	*Neither the general nor the ambassador came.*
Ni le président ni l'avocat n'écoutèrent.	*Neither the president nor the barrister listened.*
Ni vous ni moi ne le pouvons.	*Neither you nor I can do it.*
Ni toi ni lui ne le ferez.	*Neither thou nor he will do it.*
Ni le cardinal ni toi n'y réussirez.	*Neither the cardinal nor thou will succeed.*
Ni le prince M. ni le général B. ne sera nommé ambassadeur.	*Neither the Prince M. nor General B. will be appointed ambassador.*

NUMBER OF THE VERB AFTER A COLLECTIVE NOUN.

Every verb having as its subject a *general* collective noun, preceded by the definite article, such as *la totalité*, *l'infinité*, etc., takes the number of that noun:—

L'armée des infidèles fut entièrement détruite. L'ACADÉMIE.	*The army of the infidels was entirely destroyed.*
La multitude des bonnes choses que l'on trouve dans un ouvrage, fait perdre de vue la multiplicité des mauvaises. CONDILLAC.	*The multitude of the good things which we find in a work, makes us lose sight of the multiplicity of the bad ones.*

When a collective noun, followed by a plural noun in the genitive case (*i.e.*, preceded by the preposition *de*) occurs as the subject of a clause, the verb agrees with that noun, if it occupies the first rank in the thought of the speaker or writer.

The verb agrees, on the contrary, with the plural noun following the collective if the latter acts only a secondary part, or if it is employed only to add an accessory idea of number:—

Agreement with the Collective.	*Agreement with the following Noun.*
Une troupe d'assassins entra dans la chambre de Coligny. VOLTAIRE.	*Une troupe de nymphes couronnées de fleurs, nageaient autour de son char.* FÉNELON.
A gang of assassins entered Coligny's chamber.	*A troop of young nymphs, crowned with flowers, were swimming around her chariot.*

Une nuée de traits obscurcit l'air.	*Une nuée de barbares désolèrent* le pays. L'ACADÉMIE.
A cloud of arrows darkened the air.	*A cloud of barbarians desolated the country.*
Cette *espèce* de paons *paraît* avoir éprouvé les mêmes effets par la même cause. BUFFON.	Cette *espèce* de *chiens* qu'on appelle chiens de Laconie, ne *vivent* que dix ans. BOILEAU.
That species of peacocks seems to have experienced the same effects through the same cause.	*That species of dogs which they call Laconian dogs, live only ten years.*

NUMBER OF THE VERB ÊTRE AFTER THE PRONOUN CE.

The verb *être* preceded or followed by *ce*, as the grammatical subject, takes the number of the noun placed after the verb :—

Ce sont les mœurs qui font la bonne compagnie. LA CHAUSSÉE.	*It is morals which form good company.*
Sont-ce des religieux et des prêtres qui parlent ainsi? *sont-ce* des chrétiens? PASCAL.	*Are they monks and priests who speak so? are they Christians?*

The verb *être*, with *ce* as subject, is also put in the plural when it precedes the pronouns *eux* and *elles* :—

Ce sont eux qui viennent.	*It is they who come.*

Before *nous* and *vous* similarly placed, the verb is always in the singular ; *c'est* nous ; *c'est* vous.

When the verb *être* having *ce* for subject is used interrogatively and followed by a personal pronoun, it remains in the singular even before pronouns of the third person plural :—*Est-ce* lui? *Is it he? Est-ce* eux? *Est-ce* elles? *Is it they? Est-ce* nous? *Is it we? Est-ce* vous? *Is it you?*

THE VERB RELATING TO SEVERAL SUBJECTS OF DIFFERENT PERSONS.

A verb having several subjects in different persons is put in the plural, and assumes the termination of the first person in preference to that of the second, and that of the second in preference to that of the third. It may then be preceded by the plural pronoun of the person preferred, which sums up in one word all the other subjects and governs the verb :—

Votre père et *moi*, *nous avons* été longtemps ennemis l'un de l'autre. FÉNELON.	*Your father and I have long been enemies to one another.*
Allez ; *vous* et vos semblables *n'êtes* point faits pour être transplantés. MONTESQUIEU.	*Go ; you and such as you are not fit to be transplanted.*

USE OF THE TENSES.—THE PRESENT OF THE INDICATIVE.

This tense denotes what exists, or is taking place at the time we speak :—

Je lis ; vous parlez.	*I read ; you speak.*

The French have only one form of the indicative present :—

Je parle means, therefore, *I speak, do speak*, or *am speaking.*

The indicative present is used in French, as well as in English, for expressing ideas or facts which are and will always be true :—

Dieu *est* éternel, sa puissance *est* sans bornes, et sa clémence *est* grande. GIRAULT DUVIVIER.	*God is eternal, his power is boundless, and his clemency is great.*

It is often used to express a proximate future :—

Je *suis* de retour dans un moment. MOLIÈRE.	*I shall be back in a moment.*
Si Titus a parlé, s'il l'épouse, je *pars*. RACINE.	*If Titus has spoken, if he marries her, I go (will go).*

The present is frequently used for the past, to awaken attention, and place the event, as it were, before the reader :—

J'ai vu, Seigneur, j'ai vu votre malheureux fils, Traîné par les chevaux que sa main a nourris. Il *veut* les rappeler, mais sa voix les *effraie*. RACINE.	*I saw, my lord, I saw your unfortunate son dragged by the horses which his own hand has fed ; he wishes to recall them, but his voice frightens them.*

THE IMPERFECT.

The imperfect, or simultaneous past, is used to express something which was in progress while another thing was taking place. It leaves the beginning, duration, and end of an action undetermined :—

J'écrivais, quand je reçus votre lettre.	*I was writing, when I received your letter.*

The French imperfect, as may be seen in the above example, represents the English tense formed of the past tense of the auxiliary *to be* and the participle present of a leading verb.

The imperfect is also used to express repeated or customary action. It is then rendered in English by the infinitive of the verb preceded by *used to* :—

Lorsque *j'étais* à Londres, *j'allais* me promener le matin, ensuite je *dînais*, et je *passais* le reste de la journée à lire et à écrire.	*When I was in London, I walked (used to walk) in the morning, afterwards dined (usually dined), and spent (usually) the remainder of the day in reading and writing.*

The use of this tense will be further explained in the next paragraph.

THE PAST DEFINITE.

The past definite indicates an action performed at a time entirely past :—

J'*allai* à Londres, où je *vis* votre père ; je *finis* mes affaires dans cette ville, et *revins* aussitôt ici.	*I went to London, where I saw your father ; I finished my business in that city, and returned hither immediately.*
M. un tel *écrivit* hier au soir un sixain à Mademoiselle une telle. MOLIÈRE.	*Mr. such-a-one wrote last evening six verses to Miss such-a-one.*

The past definite can only be used, as we have seen above, when the time at which an action took place is entirely elapsed. We cannot, therefore, use it in connection with the words *to-day, this morning, this week, this month, this year*, etc. We may use it in speaking of *yesterday, last week, last year*, etc :—

Je vous envoie, mon cher frère, une lettre que *j'écrivis* hier pour Madame de Laval. FÉNELON.	*I send you, my dear brother, a letter which I wrote yesterday for Madame de Laval.*

As we have said, the imperfect may be rendered in English by the participle present of the leading verb and the past tense of the auxiliary *to be*; or by placing "*used to*" before the present of the infinitive. The preterite definite, however, must never be so rendered.

The imperfect may be called the ***descriptive*** **past** tense of the French language.

The past definite may be called the **narrative** tense. It expresses that which took place at some time fully past. We will endeavour to illustrate this difference between these two tenses — A traveller has entered a wood and discovered a retired cottage; he wishes to describe what he saw there, and makes use of the imperfect or descriptive tense; he says :—

Un vieillard se *promenait* sous les arbres; il *tenait* un livre à la main; de temps en temps, il *levait* les yeux vers le ciel, ou les *couvrait* de la main, et *semblait* s'abîmer dans une profonde rêverie. Devant la porte de la cabane *était* assise une femme qui *berçait* un enfant sur ses genoux; elle *était* pâle; ses cheveux *flottaient* au gré du vent; des larmes *coulaient* le long de ses joues, etc.	*An old man was walking under the trees; he was holding a book in his hand; from time to time he raised his eyes towards heaven, or concealed them with his hand, and seemed to sink into a profound reverie. Before the door of the hut was sitting a woman, who was rocking a child on her knees; she was pale; her hair was waving at the mercy of the wind; tears were flowing down her cheeks.*

The traveller has here drawn a picture of what presented itself to his eyes as he approached the cottage. Not content with representing merely the then present situation of things, he wishes also to narrate what took place. He has described the theatre on which the occurrence took place which he is going to relate; he now proceeds to the narrative, and uses the past definite or narrative tense :—

Je m'*approchai* du vieillard; lorsqu'il m'*aperçut*, il *s'avança* vers moi, me *salua* et me *pria* de ne pas troubler cette paisible retraite du malheur. Il *retourna* à la cabane, *prit* l'enfant des bras de la femme, et *rentra*; elle le *suivit*, etc	*I approached the old man; when he perceived me, he came towards me, greeted me, and besought me not to disturb this peaceful retreat of misfortune. He returned to the cottage, took the child from the woman's arms, and went in; she followed him.*

Another example taken from La Fontaine's well-known fable, in which both the imperfect and the past definite tenses are used, will illustrate the difference between them :—

LE CORBEAU ET LE RENARD.	THE RAVEN AND THE FOX.
Maître corbeau sur un arbre perché, *Tenait* en son bec un fromage; Maître renard, par l'odeur alléché, Lui *tint* à peu près ce langage.	*Master raven perched upon a tree, was holding in his beak a cheese; master fox, attracted by the smell, addressed him nearly in the following words.*

Here the poet uses the imperfect of *tenir* in describing the situation in which the fox found the raven, but in relating the action of the fox, La Fontaine uses the narrative tense of the same verb.

THE PAST INDEFINITE.

The past indefinite expresses an action entirely completed, but performed at a time of which some part is not yet elapsed, as *to-day*, *this month*, *this year*, etc. :—

Le roi m'*a nommé* aujourd'hui archevêque de Cambray. FÉNELON.	*The king appointed me to-day archbishop of Cambray.*
Ce matin *j'ai trouvé* le pavé si glissant, que *j'ai pensé* que, si je venais à tomber sur le bras droit, je serais tout à fait désemparé. BERNARDIN DE ST. PIERRE.	*This morning I found the street so slippery, that I thought in case I happened to fall on my right arm, I should then be completely helpless.*
Je t'*ai défendu* cent fois de racler ton méchant violon; cependant, je t'*ai entendu* ce *matin*.—Ce matin? Ne vous souvient-il pas que vous me le *mîtes* hier en pièces? PALAPRAT.	*"I have forbidden thee a hundred times to scrape thy wretched violin; nevertheless, I have heard thee this morning." "This morning! Do you not recollect that you broke it to pieces yesterday?"*

The past indefinite is also used with regard to a time entirely past, but not specified :—

Les fruits de la terre *ont été* la première nourriture des hommes. GIRAULT DUVIVIER.	*The fruits of the earth were the first aliments of mankind.*
Les Français *ont gagné* la bataille de Marengo.	*The French gained the battle of Marengo.*

This is at variance with the English usage.

When the time is specified and entirely elapsed, the past indefinite is by many of the best French writers used indifferently with the past definite :—

Past Definite.	*Past Indefinite.*
Huit jours après son départ, il m'*écrivit* une lettre. BERNARDIN DE ST. PIERRE.	Je vous *ai écrit*, il y a quinze jours. THE SAME.
A week after his departure, he wrote me a letter.	*I wrote to you a fortnight ago.*
Je *fus* bien fâché hier, ma chère cousine, de vous avoir quittée avec tant de précipitation. FÉNELON.	Hier en travaillant à mon quatrième dialogue, *j'ai éprouvé* un vrai plaisir. MIRABEAU.
I was very sorry yesterday, my dear cousin, for having left you in so much haste.	*Yesterday, while working at my fourth dialogue, I experienced real pleasure.*

When the first verb of a sentence is put in the past indefinite, every other verb of that sentence, and of the sentences referring to it, should be in the same tense.

THE PLUPERFECT.

The pluperfect marks a past event which was completed before another event, also past, took place, both events being independent of one another :—

J'avais déjeuné, quand vous vîntes me demander. GIRAULT DUVIVIER.	*I had breakfasted, when you came to inquire for me.*

The pluperfect, having as its auxiliary the imperfect of the verbs *avoir* or *être*, partakes of the signification of that tense. It is, therefore, used to denote a customary action, which used to take place after another customary action, in which case the latter is expressed by the imperfect :—

Dès que *j'avais lu* quelques pages, je me *promenais*.	*As soon as I had read a few pages, I used to take a walk.*

The Past Anterior.

The past anterior expresses an event which took place *immediately* before another event which is also past: the latter event being the result of, or, in its beginning, dependent upon, the former:—

Quand j'*eus reconnu* mon erreur, je *fus* honteux des mauvais procédés que j'avais eus pour lui. GIRAULT DUVIVIER.	*When I had perceived my error, I was ashamed of my bad conduct towards him.*
Dès que j'*eus lu* quelques pages, je *sortis*.	*As soon as I had read a few pages, I went away.*

NOTE.—The pluperfect may be used with the imperfect, or the past definite, or the past indefinite; whilst the past anterior can be used only with the past definite.

The Two Futures.

The future simple is used to signify what will be, or will take place, at a time not yet come:—

Votre frère *partira* demain.	*Your brother will go to-morrow.*

The future is used, in French, after the adverbs of time *quand*, *dès que*, *aussitôt que*, when futurity is implied, in which case the English use the present of the indicative:—

Quand vous *viendrez*, vous apporterez mon livre.	*When you come, you will bring my book.*

The future anterior is used to express an action which will be completed, finished at some future period; it is also used after the adverbs of time mentioned above, when the perfect definite is used in English:—

Quand j'*aurai fini* mes affaires, j'irai vous voir. GIRAULT DUVIVIER.	*When I have finished my affairs, I will go and see you.*

The Two Conditionals.

The conditional present denotes what would take place under a certain condition:—

Nous *goûterions* bien des jouissances, *si* nous savions faire un bon usage du temps. GIRAULT DUVIVIER.	*We should have many enjoyments, if we knew how to make a good use of time.*

The conditional past denotes what would have taken place, at a time past, if the condition on which it depended had been fulfilled:—

Il *serait allé* à la campagne, *si* le temps le lui avait permis.	*He would have gone into the country if the weather had allowed him.*

The two futures and the two conditionals cannot, in French, follow the conjonction *si*, meaning *if*, *in case that*. When the verb of the principal clause is in the future, the verb following *si* must be in the present indicative:—

J'*irai* vous voir demain, *si* j'*ai* le temps.	*I will call on you to-morrow, if I have time.*

When the verb of the principal clause is in the conditional, the verb following *si* must be in the imperfect indicative:—

J'*irais* vous voir demain, *si* j'*avais* le temps.	*I would call on you to-morrow if I had time.*

However, *si*, having the force of *whether*, admits of being followed by the future and the conditional:—

Je ne sais *si* j'*aurai* le temps d'aller vous voir demain.	*I do not know whether I shall have time to call on you to-morrow.*
Je ne savais pas *si* j'*aurais* le temps d'aller les voir.	*I did not know whether I should have time to call on them.*

The Imperative.

The imperative is used to express a command, exhortation, permission, or entreaty:—

Connais-moi tout entière. CORNEILLE.	*Know me entirely.*
Ah! *demeurez*, seigneur, et *daignez* m'écouter. RACINE.	*Ah! remain, my lord, and deign to listen to me.*
Ne *tardons* plus, *marchons*, et s'il faut que je meure, *Mourons*. RACINE.	*Let us tarry no longer; let us proceed; and, if I must die, let us die.*

Le Coche et la Mouche.

Dans un chemin montant, sablonneux, malaisé,
Et de tous les côtes au soleil exposé,
Six forts chevaux tiraient un coche.
Femmes, moines, vieillards, tout était descendu:
L'attelage suait, soufflait, était rendu.
Une mouche survient, et des chevaux s'approche,
Prétend à les animer par son bourdonnement,
Pique l'un, pique l'autre, et pense à tout moment
Qu'elle fait aller la machine;
S'assied sur le timon, sur le nez du cocher,
Aussitôt que le char chemine,
Et qu'elle voit les gens marcher,
Elle s'en attribue uniquement la gloire,
Va, vient, fait l'empressée; il semble que ce soit
Un sergent de bataille allant en chaque endroit
Faire avancer ses gens, et hâter la victoire.

La mouche, en ce commun besoin
Se plaint qu'elle agit seule, et qu'elle a tout le soin,
Qu'aucun n'aide aux chevaux à se tirer d'affaire.
Le moine disait son bréviaire:
Il prenait bien son temps! Une femme chantait:
C'était bien de chansons qu'alors il s'agissait!
Dame Mouche s'en va chanter à leurs oreilles,
Et fait cent sottises pareilles.
Après bien du travail, le coche arrive au haut.
"Respirons maintenant!" dit la mouche aussitôt.
"J'ai tant fait que nos gens sont enfin dans la plaine.
Çà, messieurs les chevaux, payez-moi de ma peine."

Ainsi certaines gens, faisant les empressés,
S'introduisent dans les affaires:
Ils font partout les nécessaires,
Et, partout importuns, devraient être chassés.

LA FONTAINE.

KEY TO TRANSLATION FROM FRENCH (p. 102).

ELOQUENCE OF ST. PAUL.

Do not expect of the Apostle that he came either to soothe the ear by harmonious cadences, or that he wished to charm the mind by empty curiosities. Saint Paul rejects all artifices of rhetoric. His speech, far from flowing with that pleasing sweetness, with that tempered smoothness which we admire in orators, appears uneven or unconnected to those who have not gone deeply enough into it; and the fastidious of the earth—who have, they say, a fine ear—are offended by the roughness of his irregular style. Nevertheless, my brethren, do not let us blush for it. The speech of the Apostle is simple, but his thoughts are all divine. If he ignores rhetoric, if he despises philosophy, Jesus Christ holds for him the place of everything; and His name, which he has always in his mouth, His mysteries, which he treats so divinely, will make his simplicity all-powerful. He will go, this man, ignorant of the art of saying things well, with this rude elocution—with this phraseology which savours of the stranger—he will go to polished Greece, the mother of philosophers and of orators, and in spite of the resistance of the world, he will establish there more churches than Plato has won disciples, by that eloquence which was believed to be divine. He will preach Jesus in Athens, and the most learned of her senators will pass from the Areopagus into the school of this barbarian.

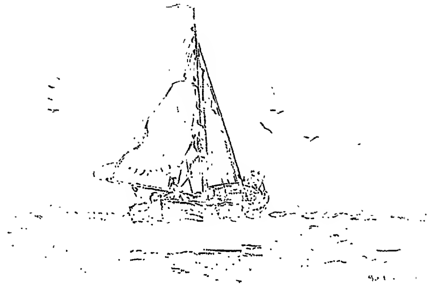
He will push his conquests still further; he will lay at the feet of the Saviour the majesty of the Roman fasces, in the person of the proconsul; and he will cause the judges before whom they summon him to tremble in their tribunals. Rome even will hear his voice, and one day this mistress city will hold herself much more honoured by a letter in the style of Paul, addressed to her fellow citizens, than by so many famous harangues which she has heard from her Cicero.

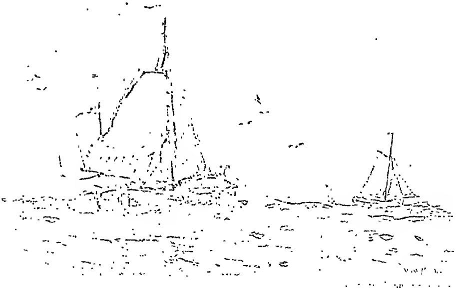
WATER-COLOUR DRAWING.—I.

INTRODUCTION — COLOURS — BRUSHES — PAPER — FLAT TINTING.

IN commencing these instructions in water-colour drawing, we shall have very little to say about the rules and practice of ordinary drawing beyond that which especially relates to our subject, having already in the previous pages of the NEW POPULAR EDUCATOR given the necessary instructions upon that division of art; but we shall not refrain from urging upon our pupils the *necessity* of good drawing, and keeping up the practice of it, as in a great measure their success in the use of water-colours will depend upon the ability they possess for representing the exact forms of objects with the lead pencil. Colours, like lines, must be put in their right places, and the power of doing this in both cases is strictly that of drawing. We do not leave off drawing when we put down the lead pencil, we simply change the instrument and continue drawing, but with other materials. The pupil is often too anxious to begin the painting and leave much of the drawing to be done, if possible, with the brush, sometimes from a total inability to carry out faithfully to the end what we should call a clear or severe outline, or from not understanding its importance: we can tell such, that if they find it difficult to represent the forms of objects truthfully with the pencil, they will not be able to fulfil their intention with the brush; and if they are desirous of finishing the picture quickly, we advise them to draw it well first, and so avoid the inevitable blotching erasures which would spoil its appearance, and cause so much discouragement. Nothing more readily exposes the defects in a drawing than filling it up with colour. for the errors and imperfections crop up as the painting advances, and many who have foolishly neglected to bestow a little more time and care upon the drawing could testify to the discouragement and failure which usually follow. The amount of labour we resolve to bestow on a painting from Nature is influenced more or less by the extent to which we intend to carry out the subject.

Drawings are generally termed *sketches* or *studies*, according to the time and attention devoted to them. A *sketch* only gives a general impression of a scene without going into elaborate details, while preserving its true character as a whole, both with respect to form and colour; and although the less important details may be omitted, yet great regard must be paid to the truthfulness of the general masses, so as to exhibit their proportions, angles, contours, tones, and effects with the greatest fidelity. The other term, *a study*, indicates that all which in a broad and general manner was begun in the sketch, has been continued with further care and attention to details, and where every part has had a due proportion of thought and labour bestowed upon it, yet without destroying the effect as a whole. In the previous lessons upon drawing we have explained how, after a little practice, the general form and character *in outline* may be easily obtained. So also in these lessons we hope to show how much colour is capable of contributing its share of character and effect; and that, with persevering zeal and attention on the part of the pupils, the power of using it will not be more difficult to attain. The first impression the mind receives of a landscape is altogether a general one, all that a *sketch* might include; but if we desire to become better acquainted with it, we stop to examine it, and obtain a closer insight into its details; we then practically make *a study* of it. First impressions teach us that objects have about them a tone which pervades all within the immediate space that surrounds them, let their colours be whatever they may, brighter and more positive as they approach, and gradually becoming more subdued and neutralised as they recede, until in the extreme distance grey tints prevail over the whole. If, when about to commence a picture from





STUDY OF DUTCH BOAT.

1. SKETCH. 2. FINISHED DRAWING.

Nature, we first make an examination of the subject, and notice the several gradations of colour and tone as they fall back in the landscape, we shall not fail to secure much upon which the character of the scene depends. This practice of observation we have before recommended; it is a study that can be pursued at any time, whether we have our materials for painting with us or not, for the book of Nature is always open, and everyone may read it when he chooses. As we wish these lessons to be especially useful to those who would prefer painting from Nature, we will direct our instructions to that end, although at the same time we hope to afford some useful hints to copyists. As a copy must be subject to the style, colour, and tone of the original, special directions about it cannot be given, as the various modes of treatment practised by artists differ so widely, and each seeks the same result by a distinct process, best understood by himself.

Our first consideration will be the implements and materials required, which we arrange in this order:—Colours, brushes, paper, three or four small saucers to contain an extra quantity of colour for broad washings, a sponge, a drawing-board, drawing-pins, a piece of wash-leather or old linen rag for wiping out the lights, and a few sheets of blotting-paper, or a blotting-pad.

Colours.—These need not be numerous; too many afford a strong temptation to use them when not necessary, and thus endanger the unity of tone so desirable throughout the picture. The most useful box is the japanned tin folding box, fitted with moist colours in pans; these are of various sizes, each having a folding leaf to be used as a palette, and the lid when open presents two or three divisions of a concave form for mixing washing tints; it is small enough to be conveniently carried in the pocket. To this must be added a japanned tin cup to hold the water; this can be fixed to the box when used. The arrangement of the colours may be as follows:—Gamboge, yellow ochre, raw sienna, *cadmium yellow*, burnt sienna, light red, *Indian red*, *vermilion*, *crimson lake*, *burnt umber*, *madder brown*, *terre verte*, *Prussian blue*, brown pink, indigo, cobalt, and sepia. Those in italics may be half cakes, the others, which come more frequently into use, should be whole cakes. It will be better to be provided also with flexible tubes of the respective colours having screw capsules, from which the pans, when exhausted, can be replenished by squeezing a portion into them. Great improvements have lately been made in the manufacture of colours of various descriptions for water-colour painting.

Brushes.—The most useful brushes are those of red sable in tin ferrules with varnished wooden handles; they are either flat or round, and are usually used for oil-painting, as they are of various sizes we recommend Nos. 1, 4, 6, and 8 for small drawings up to the size of a quarter of a sheet of imperial paper, fifteen inches by ten. There is a more expensive kind in German silver ferrules and ebony handles, but we have found those we have mentioned to be quite sufficient and serviceable.

Paper.—This is a very important consideration for the pupil, as he will be left very much to his own choice in the selection. "Whatman's" is most in use, having a firm surface. Upon paper that is too absorbent, like the cartridge papers, the colours sink in and remain dull and flat. The paper for painting upon should be a little rough, it receives the colour better than smooth hot-pressed paper: smooth papers are better for pencil drawing. An imperial sheet cut into four or eight portions furnishes very convenient sizes for drawing from Nature. These papers are to be had bound in blocks of all sizes, always ready for use, for when a drawing is completed we have only to slip a knife under the edge, pass it round, and remove the drawing, and another surface presents itself. For large drawings it would be better to fix the paper on a drawing-board in the following manner:—With a soft sponge wet both sides freely, without rubbing, lest the surface be disturbed, allow it to remain a few minutes to expand, and then turn up the edges all round about half an inch wide, and cover the edges thus turned over with stiff paste, put them down again, and place a piece of blotting-paper, folded two or three times, upon the edges, press them well down and leave them to dry; if in the course of a few minutes it is found, upon examination that the body of the paper is likely to become dry before the edges, wet the sponge again, and *dab* it over the paper, *except the pasted edges:* the object in keeping the paper damp in the middle is to secure the drying of the edges before the rest of the paper, otherwise as it contracts it will fly up. In re-damping the paper great care must be taken not to rub it; the injury this would cause would soon be discovered after the colours are laid upon it, for, the surface having been destroyed, the colours would blotch, and dark irregular patches would appear, for which there is no remedy. If the paper is merely fixed on with drawing-pins there will be no necessity to wet it, but it should be rubbed all over gently with india-rubber before commencing the outline, as the colours will then spread more evenly. Upon very hard papers, when the colour is first applied it runs together as though the paper were greasy, owing to the quantity of sizing and the pressure it receives in the manufacture; the use of india-rubber will

prevent this: some artists use a medium, or preparation of ox-gall, for this purpose, but we have found, if the india-rubber is carefully used, no disappointment ensues in the flow of the colours. If we sit too close, or bend over the drawing, we breathe upon it, and that interferes with the free spoonful will be sufficient to cover a piece of paper of the above size: the pupil must bear in mind that in all cases of flat tinting, a sufficient quantity of colour must be prepared to last through the process, for if he has to replenish the saucer before the paper is covered, he will find it difficult to

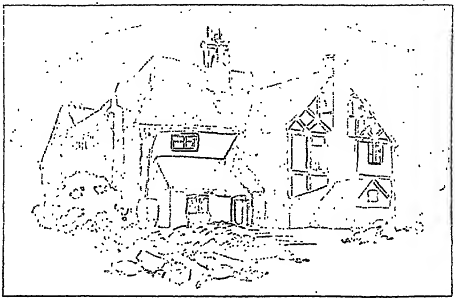


Fig. 1.

spreading of the colour; here, again, india-rubber will help us out of the difficulty. There is nothing particular to say respecting the saucers, drawing-board, and other materials, excepting the use of the blotting-pad; this is for the purpose of drawing the brush backwards along the surface in order to obtain a fine point, or to exhaust an unnecessary quantity of water it may hold before taking off any edge of colour which requires to be softened down; a much better, safer, and cleaner practice than putting the brush into the mouth, as many do.

FLAT TINTING.

The first exercise will be to make an even tint; this may be either uniform or graduated. Pin down or strain a piece of paper about the size of a quarter of a sheet of imperial; rub it all over gently with a piece of india-rubber, and place it on a table having the upper edge raised so as to form an angle of about 25° or 30°. Mix in a saucer a middle tint of sepia, indigo, lake, or any other transparent colour; about a table-

match the exact tint again, and unless he does so the surface will be irregular. For a uniform tint, he must commence at the top of the paper, avoiding the pasted edges, and with a full brush pass from left to right in a horizontal direction, fill the brush again, and pass from right to left, taking up the edge of the first layer: repeat this successively, backward and forward, *constantly replenishing the brush*, and taking especial care that *every part is covered as he proceeds*, so that there may be no necessity to retouch it, as this would produce cut shades (stains and patches), which spoil the tint. When the whole is covered to the bottom of the paper, if there is a quantity of colour remaining at the edge, exhaust the brush on the blotting paper, and pass it very carefully, without rubbing, along the overcharged parts; it will take up all that is not wanted, and then the paper may be left (still inclined) to dry. After a trial or two, a tint may be carried from the top to the bottom of a sheet of paper of any size without leaving the least mark or stain; and the more transparent the

colour, the more even will be the tint. The great secret in making an even tint lies in using *plenty of colour;* so that it may flow down after the brush as it descends; great care must be taken that the brush passes horizontally across the paper, and in no other direction. A paper tinted with a light tone of sepia is very useful for effective sepia drawings upon which the high lights may be picked out; this will engage our attention again.

A graduated tint is one that becomes darker or lighter as it extends. This is especially required for skies and backgrounds. To make a graduated tint increasing in tone, have two or three saucers prepared with different degrees of depth of colour, the first being very light. Commence all along the top of the paper with a brush full of water only, then dip it into the first tint, and pass it across once, perhaps twice, or even oftener if the extent to be covered is considerable; then continue with the second. Let us remind our pupils that in every case the brush must be kept *well charged.* The second prepared and somewhat darker tone may be repeated twice or three times across the paper; then take up the third, and as many more deeper tones as may be necessary. A graduated tint that is to become *lighter* must be commenced with the darkest, and followed with the lighter tints upon the same principle we have explained above, ending with water only. It is very difficult to wash a uniform tone with opaque colours; if after using them the result should be uneven, the only remedy is *to stipple*—that is, all the fainter and irregular parts must be filled up by short separate touches with the point of the brush, using a tint *lighter than the ground;* if the stippling tint is darker than the ground, the surface will soon be covered with spots. In this process there must be no lack of patience; the uniformity of the tone must be produced gradually; to attempt to hurry it with too dark a tint will entirely defeat the desired end. The brush must not be too wet or too dry; a medium will prevent blots on the one hand, and a coarse roughness on the other; nor must the stippling be repeated whilst the paper is wet. With these precautions a very necessary and useful kind of manipulation will be acquired, when needful, in cases of flesh tints, draperies, and sometimes in skies, etc. If some portions of the first wash should prove to be darker than are required, stipple them over with a brush containing water only, and gently rub the moistened part with a piece of rag, wash-leather, or blotting-paper; this will reduce the heavier portions, but it must be done carefully and gradually by repetition, the same

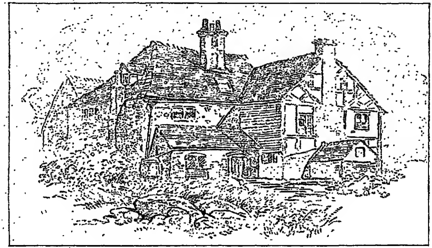


Fig. 2.

as in adding colour by stippling; in both cases all parts must be perfectly dry before working them over again; the india-rubber must not be used for removing spots, as it would be too severe and bring off more colour than needed. A gradual process must also be employed in the use of Indian ink, as it is apt to stain the paper if the first washes are too dark. For making graduated shades let the first half-dozen washes be exceedingly light, and immediately (as Indian ink dries very quickly) pass a clean wet brush, not overcharged, along the *edge* to be softened; we repeat the *edge only*, because should the water brush be carried too far into the tint the uniformity and smoothness of the shade will be destroyed; after several repetitions, the tone of the ink may be slightly increased and the shadows strengthened. Those of our pupils who have to use this material for architectural and mechanical drawings will soon discover that by patient repetition with a moderate depth of colour their work will be both brilliant and effective.

SEMI-TONES

There are one or two remarks to be made respecting the pencil to be used in drawing the outline. It must not be too hard, or too soft: if it is too hard, an impression is made upon the paper which interferes with the surface, and is difficult to remove; if it is too soft, the lead is apt to dirty the tints; therefore a middle tone, as HB, used lightly, will prevent both dangers; and no attempt must be made to shade with the pencil, as this will also destroy the purity of the tints. One of the most important regulations necessary to observe in the process of outline is that it be decisive, not black, but free from scratchy trials, which betray either a want of confidence in comprehending the exact form, or an imperfect ability to represent it. Besides bestowing especial care upon the general outline, the attention must be directed to the masses of light and shade, which must be lightly and very correctly made out, together with the positions and extent of all the most prominent semi-tones, which evidently assist in giving character and expression to the subject.

As the excellence of a picture essentially depends upon the proper management of the semi-tones and half-tints, we propose to make our first essays in sepia only; it is a warm and agreeable colour, transparent, flows freely, and is capable of producing every gradation of tone that may be required. Our motive in recommending the use of sepia before attempting colours is that our pupils may more easily acquire the power of distinguishing and the practice of representing semi-tones. By restricting our first essays to this one simple colour we break the difficulties attending the execution, and we shall be better prepared to take up colours afterwards with more confidence when our whole attention will be required in studying their gradation and harmony. It is a fact which beginners can scarcely appreciate, as they are not in a position to comprehend its great importance, that it requires considerable experience to gain a just estimate of intermediate tones. Continual observation and much practice in using the brush together prepare the pupil to discriminate tones and tints, as they lie side by side, which an uneducated eye cannot perceive; to acquire this constitutes the course of study we wish our pupils to follow. In pursuit of this they must especially notice that they will discern two conditions under which they will find the various changes that arise in connection with shade and colour. With the former we may associate *tone*, with the latter *tint*; therefore, we trust there will be no difficulty in understanding why, at the commencement of our lessons, we prefer to separate the difficulties attending these two conditions respectively; consequently, *tone* will be our first consideration in this lesson.

In all the broad and general masses of light and shade there will invariably be found several degrees of brilliancy or obscurity, sometimes arising from one part being more strongly illuminated than another: for if the face of an object is perpendicular or at right angles with the source or rays of light, it then receives the greatest amount of illumination; and as it is gradually removed from the light the brilliancy decreases until, when it has been turned altogether out of the course of the light, it falls into shadow. Thus, when the surface is not very even, it is evident that some parts receive more rays from the light than others. These accidental causes will break up the uniformity of the light or shade into a thousand different and distinctive gradations of tone. So also in the shadows; reflected light may strike more forcibly upon one part than another. If, then, we connect these countless varieties of tone with the various colours of the object and their several degrees, we are led into a course of study and reflection that has no limit. But we must observe, however numerous these changes may be, they do not interfere with the *masses* of light and shade in their unity as a whole. Let the pupil half close his eyes when looking on an object upon which there is no restriction in the number of tones and tints; he will perceive that all the perceptible degrees of light or shade, including all the changes of colour found within their respective limits, blend together or are absorbed into one definable mass of light on the

one hand. and shadow on the other; therefore, the result of our observations teaches us this: that our difficulties will not be so much with positive light and shade, or with positive colour, but with the infinite variety and accidental changes that are to be found in combination with them.

To give the above remarks some practical meaning we propose to make Figs. 1 and 2 the subject for a sepia drawing. After the whole of the outline and details of form have been completed, prepare a light wash of sepia in a saucer, and commence as in Fig. 1 to put in the background for the purpose of relieving or throwing up the whole of the subject, after the manner explained in the first lesson of washing in a flat tint (we will not call this background sky—skies will be the subject of a future lesson), and proceed as follows. Let the paper be inclined, and pass a brushful of water across the upper part of the picture from *a* to *a*; then fill the brush with the previously prepared light tone of sepia, and continue from, and including, the lower edge of the water, and spread it across from side to side and around the outline of the building. Before the edges *b*, *b* become dry, wash them off with the water brush moderately charged, so that the background, when finished, may be graduated outwardly. Be particular in having plenty of colour in the brush, and see that every part is covered as the brush proceeds, so that it may not be necessary to re-touch it whilst wet, for if the tint is interfered with by trying to fill up vacant spaces, cut shades will appear when the picture is dry. For the broad and cast shadows add some more sepia to that which remains in the saucer to produce a middle tone, darker than that of the background, and equal to the lightest parts of the shadows; with this paint in all the broad and cast shadows upon the walls in one uniform tone, as well as those parts which are of a similar depth of colour, viz., the tiles, windows, and the grass and stones upon the ground; then, when dry, and with the same colour, make out those portions of the shaded walls, roof, and ground which are darker, according to Fig. 2. Many of these semi-tones may be partly passed over a second time, and in some cases a third, especially the cast shadows on the roof that lies under the wall of the highest part of the building. For the more delicate tones upon the light side of the building prepare a tint weaker than any yet used, with which, by careful management, the stones and bricks which compose the wall can be shown as well as those differences of colour known as weather stains, to be found on every wall, but especially old ones, besides many degrees of tone that other accidental circumstances, such as damp or decay, may produce. Last of all, the finishing touches may be added with some darker tint, carefully making out the forms of the windows, stones, weeds, etc., *without painting dark lines about the edges*. All objects and parts of objects should as far as possible be made out *by tones* carried strictly to their edges; thus everything will be properly relieved and understood, whether it appears light upon a dark ground, or dark upon a light one. Beginners frequently draw a line of a darker colour around the edges of objects, thinking they are adding to the effect by making everything more distinct: the fact is, the effect is destroyed by dark lines; they make the picture flat; and as these dark edges are never seen in Nature, we are not justified in using them. We have yet a few observations to make upon Fig. 2. There are not many cast shadows, and it must be remembered that, as a general rule, cast shadows are darker than broad shadows. The reason that the cast shadow on the tiles, caused by the intervention of the higher portion of the building, is darker than the broad shadow on the side of the building, is that the reflected light from the roof lowers the tone of the broad shadow without making any difference to the cast shadow as it falls upon the same plane, that is, the roof. By a proper attention to semi-tones in lights, and to reflections in shadows, we do more to give relief and effect to the picture than by any other means. Colours, however forcible their contrasts may be, will only produce a map-like flatness without the indispensable addition of semi-tones and reflections. Therefore we advise our pupils to continue the use of sepia only for some time, until they have acquired a sufficient power of execution and an insight into some of the mysteries that lie between the two extremes of light and shade.

ELOCUTION.—II.

[*Continued from p. 111.*]

PUNCTUATION (*continued*).

IV. THE COMMA.

22. *The mark used for a comma is a round dot with a small curve appended to it, turning from right to left.*

23. When you come to a comma in reading, you must, in general, make a short pause or stop, so long as would enable you to count *one*.

24. The last word before a comma is most frequently read with the falling inflection of the voice.

25. In reading, when you come to a comma, you

must keep your voice suspended as if someone had stopped you before you had read all that you intended to read.

26. In the following examples keep your breath suspended when you come to the comma; but let the short pause or stop which you make be a *total cessation* of the voice.

Examples.

The genuine glory, the proper distinction of the rational species, arises from the perfection of the mental powers.

Courage is apt to be fierce, and strength is often exerted in acts of oppression.

Wisdom is the associate of justice. It assists her to form equal laws, to pursue right measures, to correct power, to protect weakness, and to unite individuals in a common interest and general welfare.

Heroes may kill tyrants, but it is wisdom and laws that prevent tyranny and oppression.

27. When a note of interrogation occurs at the end of a sentence, the parts, and even the words, of the sentence separated by commas, should each be read like a question.

Examples.

For what is our hope, our joy, or crown of rejoicing?

Have you not misemployed your time, wasted your talents, and passed your life in idleness and vice?

Have you been taught anything of the nature, structure, and laws of the body which you inhabit?

Were you ever made to understand the operation of diet, air, exercise, and modes of dress, upon the human frame?

28. Sometimes the word preceding a comma is to be read like that preceding a period, with the falling inflection of the voice.

Examples.

It is said by unbelievers that religion is dull, unsociable, uncharitable, enthusiastic, a damper of human joy, a morose intruder upon human pleasure.

Nothing is more erroneous, unjust, or untrue, than the statement in the preceding sentence.

Perhaps you have mistaken sobriety for dulness, equanimity for moroseness, disinclination to bad company for aversion to society, abhorrence of vice for uncharitableness, and piety for enthusiasm.

The history of religion is ransacked by its enemies for instances of persecution, of austerities, and of enthusiastic irregularities.

Religion is often supposed to be something which must be practised apart from everything else, a distinct profession, a peculiar occupation.

29. Sometimes the word preceding a comma is to be read like that preceding an exclamation.

Examples.

How can you destroy those beautiful things which your father procured for you! that beautiful top, those polished marbles, that excellent ball, and that beautifully painted kite, oh, how can you destroy them, and expect that he will buy you new ones!

O Winter! ruler of the inverted year! thy scattered hair with sleet-like ashes filled, thy breath congealed upon thy lips, thy cheeks fringed with a beard made white with other snows than those of age, thy forehead wrapped in clouds, a leafless branch thy sceptre, and thy throne a sliding car, indebted to no wheels, but urged by storms along its slippery way, I love thee, all unlovely as thou seemest, and dreaded as thou art!

Lovely art thou, O Peace! and lovely are thy children, and lovely are the prints of thy footsteps in the green valleys.

30. Sometimes the word preceding a comma and other marks, is to be read without any pause or inflection of the voice.

Examples.

You see, my son, this wide and large firmament over our heads, where the sun and moon, and all the stars appear in their turns.

Therefore, my child, fear and worship, and love God.

He that can read as well as you can, James, need not be ashamed to read aloud.

I consider it my duty, at this time, to tell you that you have done something of which you ought to be ashamed.

The Spaniards, while thus employed, were surrounded by many of the natives, who gazed, in silent admiration, upon actions which they could not comprehend, and of which they did not foresee the consequences. The dress of the Spaniards, the whiteness of their skins, their beards, their arms, appeared strange and surprising.

31. Sometimes the pause of a comma must be made where there is no comma in the book. Spaces are left in the following sentences where the pause is proper to be made.

Examples.

The Europeans were hardly less amazed at the scene now set before them.

Their black hair long and curled floated upon their shoulders or was bound in tresses around their head.

Persons of reflection and sensibility contemplate with interest the scenes of nature.

The succession and contrasts of the seasons give scope to care and foresight diligence and industry which are essential to the dignity and enjoyment of human beings.

The eye is sweetly rested on every object to which it turns. It is grateful to perceive how widely yet chastely Nature hath mixed her colours and painted her robe.

Winter compensates for the want of attractions abroad by fireside delights and homefelt joys. In all this interchange and variety we find reason to acknowledge the wise and benevolent care of the God of seasons.

32. The pupil may read the following sentences; but before reading them he should point out after what word the pause should be made. The pause is not printed in the sentences, but it must be made when reading them. And here it may be observed, that the comma is more frequently used to point out the grammatical divisions of a sentence than to indicate a rest or cessation of the voice. Good reading depends much upon skill and judgment in making those pauses which the meaning of the sentence dictates, but which are not noted in the book; and the sooner the pupil is taught to make them with proper discrimination, the surer and more rapid will be his progress in the art of reading.

Examples.

The golden head that was wont to rise at that part of the table was now wanting.

For even though absent from school I shall prepare the lesson.

For even though dead I will control the trophies of the capitol.

It is now two hundred years since attempts have been made to civilise the North American savage.

Doing well has something more in it than the fulfilling of a duty.

You will expect me to say something of the lonely records of the former races that inhabited this country.

There is no virtue without a characteristic beauty to make it particularly loved by the good, and to make the bad ashamed of their neglect of it.

A sacrifice was never yet offered to a principle, that was not made up to us by self-approval, and the consideration of what our degradation would have been had we done otherwise.

The succession and contrast of the seasons give scope to that care and foresight, vigilance and industry, which are essential to the dignity and enjoyment of human beings, whose happiness is connected with the exertion of their faculties.

A lion of the largest size measures from eight to nine feet from the muzzle to the origin of the tail, which last is of itself about four feet long. The height of the larger specimens is four or five feet.

A benison upon thee, gentle huntsman! Whose towers are these that overlook the wood?

The incidents of the last few days have been such as will probably never again be witnessed by the people of America, and such as were never before witnessed by any nation under heaven.

To the memory of Andre his country has erected the most magnificent monument, and bestowed on his family the highest honours and most liberal rewards. To the memory of Hale not a stone has been erected, and the traveller asks in vain for the place of his long sleep.

V. THE SEMICOLON.

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33. *The Semicolon is formed by a period placed above a comma.*

34. When you come to a semicolon in reading, you must in general make a pause twice as long as you would make at a comma.

35. Sometimes you must use the falling inflection of the voice when you come to a semicolon, and sometimes you must keep your voice suspended, as directed in the case of the comma. Whatever may be the length of the pause, let it be a *total cessation* of the voice.

Examples.

My son, as you have been used to look to me in all your actions, and have been afraid to do anything unless you first knew my will; so let it now be a rule of your life to look up to God in all your actions.

If I have seen any perish for want of clothing, or any poor without covering; if his loins have not blessed me, and if he were not warmed with the fleece of my sheep; if I have lifted up my hand against the fatherless, when I saw my help in the gate; then let mine arm fall from my shoulder-blade, and mine arm be broken from the bone.

The stranger did not lodge in the street; but I opened my doors to the traveller.

If my land cry against me, or the furrows thereof complain; if I have eaten the fruits thereof without money or have caused the owners thereof to lose their life; let thistles grow instead of wheat, and cockles instead of barley.

When the battle was ended, the stranger disappeared; and no person knew whence he had come, nor whither he had gone.

The relief was so timely, so sudden, so unexpected, and so providential; the appearance and the retreat of him who furnished it were so unaccountable; his person was so dignified and commanding; his resolution so superior, and his interference so decisive, that the inhabitants believed him to be an angel, sent by Heaven for their preservation.

36. Sometimes you must use the falling inflection of the voice when you come to a semicolon in reading.

Examples.

Let your dress be sober, clean, and modest; not to set off the beauty of your person, but to declare the sobriety of your mind; that your outward garb may resemble the inward plainness and simplicity of your heart.

In meat and drink, observe the rules of Christian temperance and sobriety; consider your body only as the servant and minister of your soul; and only so nourish it, as it may best perform a humble and obedient service.

Condescend to all the weaknesses and infirmities of your fellow-creatures; cover their frailties; love their excellences; encourage their virtues; relieve their wants; rejoice in their prosperity; compassionate their distress; receive their friendship; overlook their unkindness; forgive their malice; be a servant of servants; and condescend to do the lowest offices for the lowest of mankind.

Struck with the sight of so fine a tree, he hastened to his own, hoping to find as large a crop upon it; but, to his great surprise, he saw scarcely anything, except branches, covered with moss, and a few yellow leaves.

In the sight of our law the African slave-trader is a pirate and a felon; and in the sight of Heaven, an offender far beyond the ordinary depth of human guilt.

What hope of liberty is there remaining, of whatever is their pleasure, it is lawful for them to do, if what is lawful for them to do, they are able to do, if what they are able to do, they dare do; if what they dare do, they really execute; and what they execute, is in no way offensive to you?

It is not the use of the innocent amusements of life which is dangerous, but the abuse of them; it is not when they are occasionally, but when they are constantly pursued; when the love of amusement degenerates into a passion; and when, from being an occasional indulgence, it becomes an habitual desire.

37. The semicolon is sometimes used as a note of interrogation, and sometimes as an exclamation.

Examples.

Why, for so many a year, has the poet and the philosopher wandered amidst the fragments of Athens or of Rome; and paused with strange and kindling feelings, amidst their broken columns, their mouldering temples, their deserted plains? It is because their day of glory is past; it is because their name is obscured; their power is departed; their influence is lost!

Where are they who taught these stones to grieve; where are the hands that hewed them; and the hearts that reared them?

Hope ye by these to avert oblivion's doom, in grief ambitious, and in ashes vain?

Can no support be offered, can no source of confidence be named?

Is this the man that made the earth to tremble, that shook the kingdoms; that made the world like a desert; that destroyed the cities?

Falsely luxurious, will not man awaken; and, springing from the bed of sloth, enjoy the cool, the fragrant, and the silent hour, to meditation due, and sacred song?

But who shall speak before the king when he is troubled; and who shall boast of knowledge when he is distressed by doubt?

Who would in such a gloomy state remain longer than nature craves; when every muse and every blooming pleasure wait without, to bless the wildly devious morning walk?

What a glorious monument of human invention, that has thus triumphed over wind and wave; has brought the ends of the earth in communion; has established an interchange of blessings, pouring into the sterile regions of the north all the luxuries of the south; diffused the light of knowledge and the charities of cultivated life; and has thus bound together those scattered portions of the human race, between which nature seems to have thrown an insurmountable barrier!

Who that bears a human bosom, hath not often felt how dear are all those ties which bind our race in gentleness together; and how sweet their force, let fortune's wayward hand the while be kind or cruel?

VI. THE COLON.

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38. *The Colon is composed of two periods, placed one above the other.*

39. Sometimes the passage ending with a colon is to be read with the voice suspended; but it should generally be read with the falling inflection of the voice.

40. In reading, be careful to let the pause of the colon be a *total cessation* of the voice, and three times longer than that indicated by a comma.

Examples.

The smile of gaiety is often assumed while the heart aches within: though folly may laugh, guilt will sting.

There is no mortal truly wise and restless at the same time: wisdom is the repose of the mind.

Nature felt her inability to extricate herself from the consequences of guilt: the gospel reveals the plan of Divine interposition and aid.

Nature confessed some atonement to be necessary: the gospel discovers that the atonement is made.

Law and order are forgotten: violence and rapine are abroad: the golden cords of society are loosed.

The temples are profaned: the soldier's curse resounds in the house of God: the marble pavement is trampled by iron hoofs: horses neigh beside the altar.

Blue wreaths of smoke ascend through the trees, and betray the half-hidden cottage: the eye contemplates well-thatched ricks, and barns bursting with plenty: the peasant laughs at the approach of winter.

The necessaries of life are few, and industry secures them to every man: it is the elegancies of life that empty the purse: the superfluities of fashion, the gratification of pride, and the indulgence of luxury, make a man poor.

VII. THE PARENTHESIS, CROTCHETS, AND BRACKETS.

( ) [ ]

41. *A Parenthesis is a sentence, or part of a sentence, enclosed between two curved lines, thus* ( ).

42. The curved lines in which the parenthesis is enclosed are called Crotchets.

43. The parenthesis, with the crotchets which enclose it, is generally inserted between the words of another sentence, and may be omitted without injuring the sense.

44. The parenthesis should generally be read in a quicker and lower tone of voice than the other parts of the sentence in which it stands.

45. Sometimes a sentence is enclosed in marks like these [ ], which are called Brackets.

46. Sentences which are included within brackets should generally be read in a quicker and lower tone of voice.

47. Although the crotchet and the bracket are sometimes used indiscriminately, the following difference in their use may be noticed:—Crotchets are used to enclose a sentence, or part of a sentence, which is inserted *between the parts* of another sentence; brackets are generally used to separate two subjects, or to enclose an explanation, note, or observation, standing by itself. When a parenthesis occurs within another parenthesis, brackets enclose the former, and crotchets enclose the latter.

Examples.

I asked my eldest son (a boy who never was guilty of a falsehood) to give me a correct account of the matter.

The master told me that the lesson (which was a very difficult one) was recited correctly by every pupil in the class.

When they were both turned of forty (an age in which, according to Mr. Cowley, there is no dallying with life), they determined to retire, and pass the remainder of their days in the country.

Notwithstanding all this care of Cicero, history informs us that Marcus proved a mere blockhead; and that Nature (who, it seems, was even with the son for her prodigality to the father) rendered him incapable of improving, by all the rules of eloquence, the precepts of philosophy, his own endeavours, and the most refined conversation in Athens.

Natural historians observe (for whilst I am in the country I must fetch my allusions from thence) that only the male birds have voices; that their songs begin a little before breeding time, and end a little after.

Dr. Clark has observed that Homer is more perspicuous than any other author; but if he is so (which may yet be questioned), the perspicuity arises from his subject, and not from the language itself in which he writes.

My father and my uncle Toby (clever soul) were sitting by the fire with Dr. Slop; and Corporal Trim (a brave and honest fellow) was reading a sermon to them.

As the sermon referred to in the above extract contains many parentheses, and affords an opportunity also of showing you a sentence in brackets (you will observe that all the previous parentheses in this lesson are enclosed in crotchets), we shall insert part of it in the following paragraph:—

To have the fear of God before our eyes, and in our mutual dealings with each other, to govern our actions by the eternal measures of right and wrong: the first of these will comprehend the duties of religion; the second those of morality, which are so inseparately connected together, that you cannot divide these two tables, even in imagination (though the attempt is often made in practice), without

breaking and mutually destroying them both. [Here my father observed that Dr. Slop was fast asleep.] I said the attempt is often made; and so it is; there being nothing more common than to see a man who has no sense at all of religion, and, indeed, has so much honesty as to pretend to none, who would take it as the bitterest affront should you but hint at a suspicion of his moral character, or imagine he was not conscientiously just and scrupulous to the uttermost mite.

I know the banker I deal with, or the physician I usually call in ["There is no need," cried Dr. Slop (waking), "to call in any physician in this case"], to be neither of them men of much religion.

Experienced schoolmasters may quickly make a grammar of boys' natures, and reduce them all (saving some few exceptions) to certain general rules.

Ingenious boys, who are idle, think, with the hare in the fable, that running with snails (so they count the rest of their school-fellows), they shall come soon enough to the post; though sleeping a good while before their starting.

HYDRAULICS.—VII.

[Continued from p. 125.]

STEADY FLOW OF WATER.

FRICTIONAL LOSS OF ENERGY BY WATER IN PIPES AND CHANNELS—PRONY'S APPROXIMATION—TOTAL STORE OF ENERGY IN WATER—PRESSURE ENERGY—KINETIC ENERGY AND POTENTIAL ENERGY—TRANSMISSION OF POWER BY PRESSURE-WATER—LAW GIVING THE POWER IN ANY QUANTITY OF PRESSURE-WATER—POWER LOST IN PIPES IN TERMS OF POWER, PRESSURE, SIZE OF PIPE—BEST PRESSURE AND SIZE OF PIPE TO USE.

FRICTION OF WATER IN PIPES AND CHANNELS.

THE energy wasted in transmission over long distances by water under pressure can only be obtained by actual experiment. It is usual to assume that fluid friction is independent of pressure. Though water is not absolutely free from internal friction or viscosity, it is mainly the frictional resistance to the motion of the water between the surface layers and the liquid film plastered on the metal pipe which comes into the question as the most important factor.

Useful data on this point are available from the elaborate experiments of Darcy. With clean iron pipes the friction is found to vary considerably with the nature of the surface of the pipe; whilst old pipes encrusted with deposits give about twice as great a frictional resistance as new and clean pipes offer.

The friction of water in pipes and channels may be taken as directly proportional to the extent of washed surface.

If d stand for diameter of pipe in feet;
A „ „ cross sectional area of pipe or channel;
l „ „ length of pipe or channel in feet;
b „ „ wetted border;
πdl „ „ washed surface;

then Darcy's experiments inform us that every pound of water loses $f\frac{lb}{A}$ times its whole store of kinetic energy in passing along a pipe l feet in length and d feet in diameter, where f is a number or coefficient depending on the nature of the surface and the diameter of the pipe, and derived directly from experiment.

According to Darcy,

$$\text{for clean cast-iron pipes, } f = \cdot005\left(1 + \frac{1}{12d}\right).$$

$$\text{for slightly encrusted pipes, } f = \cdot01\left(1 + \frac{1}{12d}\right).$$

$$\text{for clean 6-inch cast-iron pipes, } f = \cdot0058.$$

From this we can find the energy lost in overcoming friction in hydraulic transmission—that is to say, the head lost in friction. The energy lost per pound of water, or head lost in l feet length of straight cast-iron pipe, is given by the formula—

$$\text{loss of energy} = f\frac{lb}{A}\frac{v^2}{2g}\text{ ft.-lb.},$$

since the kinetic energy in 1 lb. is $\frac{v^2}{2g}$.

Now in the case of round pipes filled with water, the

$$\text{hydraulic mean depth} = \frac{\text{sectional area}}{\text{wetted perimeter}} =$$

$$\text{or} \qquad = \frac{\pi d^2}{4} \div \pi d,$$

and therefore

$$\frac{A}{b} = \frac{d}{4}.$$

Hence, for ordinary round pipes

$$\text{Loss of energy per 1 lb. of water} = f\frac{4l}{d} \times \frac{v^2}{2g} \quad . \quad . \quad (1)$$

If the water flows through the pipe at the rate of

$$Q \text{ cubic feet of water per second,}$$

then

$$60 \times 62\cdot4 \times Q \text{ lb. of water passes per minute;}$$

also

$$\text{velocity of flow } v = \frac{Q}{A} = \frac{Q}{\frac{\pi}{4}d^2};$$

so that

$$v^2 = \frac{16Q^2}{\pi^2 d^4},$$

and we thus find for Q cubic feet of water passing per second in round pipes,

$$\left.\begin{matrix}\text{loss of energy}\\ \text{per minute}\end{matrix}\right\} = f\frac{2l}{dg} \times \frac{16Q^2}{\pi^2 d^4} \times 60 \times 62\cdot4 \times Q \text{ ft.-lb.} \quad . \quad (2)$$

Therefore this expression divided by 33,000 gives the horse-power lost in friction by the transmission of water through round pipes. When these are of cast-iron, the value of f is given by the above formula, whilst $g = 32\cdot2$, and $\pi = 3\cdot1416$.

PRONY'S APPROXIMATION.

Before taking up the practical application of this result, it is worthy of note that for water flowing in

closed pipes, Prony's approximation is very simple and easily recollected:—

$$H = \frac{2\cdot25v^2}{d},$$

where H stands for fall in *feet per mile*;
v „ „ velocity of flow in *feet per second*;
d „ „ diameter of pipe in *feet*.

The great utility of this formula will be best understood by an example or two.

EXAMPLE 1.—How many cubic feet of water would be delivered per second from a pipe 3 feet in diameter, 25 miles long, and with a constant head of 146 feet?

Here, $H = \frac{146}{25}$, and $d = 3$, so we can readily find first the velocity of flow, by putting these values in the formula.

Thus,

$$\frac{146}{25} = \frac{2\cdot25v^2}{3};$$

so that

$$v^2 = \frac{3 \times 146}{25 \times 2\cdot25} = 7\cdot78,$$

and

$$\therefore\ v = 2\cdot79 \text{ feet per second.}$$

Then

$$Q = Av = \text{cross section of pipe} \times \text{velocity of flow}$$
$$= \cdot7854 \times 3^2 \times 2\cdot79.$$
$$\therefore\ Q = 19\cdot72 \text{ cubic feet per second.}$$

other words, about 20 cubic feet of water are delivered per second.

EXAMPLE 2.—Required the diameter of a pipe to deliver 30 cubic feet of water per second with head of 160 feet and length 25 miles.

We are given Prony's formula,

$$H = \frac{2\cdot25v^2}{d};$$

$$\text{where velocity of flow } v = \frac{Q}{A} = \frac{Q}{\cdot7854d^2},$$

that is,

$$H = \frac{160}{25} = \frac{2\cdot25Q^2}{\cdot6168d^5},$$

whence,

$$d = \sqrt[5]{\frac{3\cdot047Q^2}{H}}$$

Thus,

$$d = \sqrt[5]{\frac{3\cdot047 \times 30^2}{\frac{160}{25}}} = \sqrt[5]{512} = 3\cdot48 \text{ ft.} \quad \textit{Answer.}$$

TOTAL STORE OF ENERGY IN WATER. PRESSURE ENERGY.

From the above it appears that in the transmission of power by water in pipes, the loss of energy due to friction may be readily expressed as a fraction of the kinetic energy in the water, since this loss is caused by the motion of the water or, rather, by the frictional resistance offered to the moving water by the surface layers against the pipes, neglecting viscosity of the water. We have also seen that in the discharge of water through orifices the frictional loss of energy is simply expressed as a fraction of the whole kinetic energy of the water, owing to its velocity of flow at the nozzle or mouthpiece, where the friction principally takes place. In this case the potential energy of the water, in virtue of its head or height above datum level, is changed into kinetic energy whilst falling through the difference of level between the free surface of still water and the orifice.

Moreover, at any time when under the action of gravity there is a *steady flow of water through a horizontal pipe*, the potential energy remains the same everywhere, but if the pipe vary in section, being contracted at one point and enlarged at another, the velocity of flow is inversely proportional to the cross sectional area of pipe, so that the kinetic energy in the water may be either increased or diminished by contracting or enlarging the pipe, whilst the pressure of the water is found to be thereby reduced or increased in exactly the same proportion.

As a matter of fact, it would appear that in the steady flow of water from one place to another, part of the whole store of energy in the water is due to pressure and may be called *pressure energy*. The necessity for this term may also be seen if we consider a small portion of water moving towards the discharge orifice in a vessel. At a point inside the vessel, nearly on a level with the orifice, the velocity of the water may be so small that its gain of kinetic energy does not nearly equal its loss of potential energy. Hence, some other kind of energy must have been given to the water, and as a matter of fact, it is now under pressure and has pressure energy.

Again, we see that in the nearly still water on a level with the orifice the water is under pressure; and we know (lesson III., page 319) that at a depth of h feet below still-water level, where the pressure intensity is p lb. per square inch,

$$p = \frac{h}{2\cdot3} \text{ so that } h \doteq 2\cdot3\,p.$$

Now, the *pressure energy* in every pound of water at this point, when there is a steady continuous flow, represents the work which the rest of the water in the vessel will do upon 1 lb. of water in raising it slowly h feet to the free-surface level, that is, $2\cdot3p$ ft.-lb.

The relation between these quantities—
p = fluid pressure in lb. per square inch,
f = fluid pressure in lb. per square foot,
w = the weight (62·4 lb.) of 1 cubic foot of water—
is then

$$f = 144p = 62\cdot4h;$$

so that

$$\frac{f}{w} = 2\cdot3p.$$

Thus, a pound of water subjected to a pressure of p lb. per square inch possesses $2{\cdot}3p$ ft.-lb. of energy in the form called pressure energy, in virtue of this constant steady pressure. From this it follows that a pound of water at the pressure of the atmosphere, 14·73 lb. per square inch, has in virtue of this steady pressure a store, 2·3 × 14·73 or 34 ft.-lb. of pressure energy.

However, we must bear in mind that since *water is practically incompressible*, it cannot be said to do work when the pressure is relieved, since there is practically no expansion.

Only when water flowing under pressure is followed by other water at a like pressure, and we know there is a steady flow which will not be suddenly destroyed or altered, can we assume that the water has pressure energy, which may be converted into other forms of energy and put to good account. Such pressure-water may be used to drive hydraulic machinery, so that every pound and every cubic foot of it possesses a mercantile value like any other useful form of energy.

We are now in a position to consider the fundamental law for the *whole energy of every pound of water*. In problems connected with the *steady flow* of water it is convenient to express the total energy of a pound of the water as the sum of three terms due to its *velocity*, *position*, and *pressure*, as

Kinetic Energy + Potential Energy + Pressure Energy,

or

$$\text{Total energy of 1 lb.} = \frac{v^2}{64{\cdot}4} + h + 2{\cdot}3p \text{ ft.-lb.}$$

Where v is velocity of flow in feet per second,
h is height in feet above some datum level,
and p is pressure in lb. per square inch.

No matter how any one of these stores of energy may alter, the *sum* of the three terms remains the same, except that there is always frictional loss, which is proportional to the kinetic energy.

There is supposed to be a *steady flow of water* under the action of gravity alone. The law no longer holds true when any other forces than that of gravity act on the water, because then we have a change in the total store of energy in that quantity of water. For instance, in the case of water lifted by a pump, the store of energy in 1 lb. of this water is not constant. But in hydraulic pipes and mains, where the water is not receiving additional energy whilst the pumps are merely keeping the pressure constant and the flow steady, then our law may be taken as true.

We include in the expression for the total energy in every pound of water,

$$\frac{v^2}{64{\cdot}4} + h + 2{\cdot}3p.$$

First Term: **Kinetic Energy.**—Because when w lb. of water is in steady motion, and its velocity of flow is v feet per second, its *kinetic energy*, or energy of motion, is

$$\frac{1}{2}\frac{w}{g}v^2, \text{ that is, } \tfrac{1}{2}(\text{mass}) \times (\text{velocity})^2;$$

and, since the mass of one pound is $\frac{1}{32{\cdot}2}$, its store of energy in virtue of its motion alone is

$$\frac{1}{2} \times \frac{1}{32{\cdot}2}v^2,$$

that is to say, $\frac{1}{64{\cdot}4}$th of the square of the velocity in feet per second.

Second Term: **Potential Energy.**—When w lb. weight of water is h feet above some datum level, there is stored up in this water, owing to its position, *potential energy* equal in amount to wh ft.-lb., the weight of the water in pounds multiplied by the height in feet through which it can fall, because in falling through this difference of level it could do wh ft.-lb. of mechanical work, provided there were no loss in friction. Hence, 1 lb. of water free to fall through h feet difference of level has a store of h ft.-lb. of potential energy.

Third Term: **Pressure Energy.**—Because the flow is steady and the pressure is p lb. per square inch, every pound of the water possesses in virtue of the steady motion and pressure a store of energy equal in amount to $2{\cdot}3p$ ft.-lb.

When water flows in hydraulic mains for the transmission of power, its *pressure* energy is of most importance: the velocity of flow being usually small and the difference of level unimportant.

TRANSMISSION OF POWER BY PRESSURE-WATER.

It is easy to calculate the store of pressure energy in any given *weight or volume of such water*. Assume that the water is practically incompressible and that, at the ordinary temperature, every cubic foot of water weighs 62·4 lb. Then, for every cubic foot of water at a pressure of 700 lb. per square inch, the store of pressure energy is

$$2{\cdot}3 \times 700 \times 62{\cdot}4 = 100{,}464 \text{ ft.-lb.}$$

In order to measure or calculate the energy used up in a given time—that is, the power supplied to a merchant to work hoists, etc.—we require to know two things—namely, the **quantity** of water used per second, and its **pressure**. For every pound of water sent into the supply pipe at pressure of p lb. per square inch, we know that

$2{\cdot}3p$ ft.-lb. is pressure energy of 1 lb.,

so that

$144p$ ft.-lb. is pressure energy of 1 cubic foot.

Hence, in Q cubic feet of water flowing at a pressure of p lb. per square inch there is a store of

$144pQ$ ft.-lb. of pressure energy.

When the flow of such water, under pressure of p lb. per square inch, is at the rate of Q cubic feet per second, the energy put into the pipe in the water supplied is

$$144pQ \times 60 \text{ ft.-lb. per minute;}$$

and since a *horse-power* is the rate of doing or supplying 33,000 ft.-lb. of work per minute, the total power put into the water entering the pipe is in horse-power

$$P = \frac{144 \times 60pQ}{33000} = 0{\cdot}2605pQ \quad . \quad . \quad . \quad . \quad (3)$$

It is obvious from this important formula that with a given quantity Q cubic feet of water, we can have more power transmitted by increasing the pressure. Moreover, when the motion is steady, we may assume that the friction is the same for the same quantity of water that flows through the pipes. Clearly, then, there is a great saving by using high-pressure water.

Now, if v feet per second be the rate of flow of water in a pipe d feet in diameter, we have, as above

$$Q = \text{cross sectional area of pipe} \times \text{velocity of flow},$$

$$\therefore Q = \frac{\pi}{4}d^2 \times v, \text{ so that } v = \frac{4Q}{\pi d^2};$$

and by equation (3)

$$Q = \frac{P}{\cdot 2605p},$$

the quantity of water at given pressure p necessary to supply P horse-power.

Substitute these values for Q and v in equation (2), page 175, and take the value of the frictional coefficient given by Darcy's experiments for a clean, new 6-inch pipe, as $f = 0{\cdot}0058$, we find

$$\text{Power lost in pipe} = 0{\cdot}00375\,\frac{lP^3}{p^3d^5} \quad . \quad . \quad . \quad . \quad (4)$$

Where P is the horse-power put into water at pressure of p lb. per square inch, on entering the pipe d feet in diameter and l feet in length.

It is evident from this formula that the waste of power in transmission is inversely as the cube of the pressure. We can therefore transmit any given amount of power with much less waste and a smaller quantity of water by giving to it greater pressure. With exceedingly high pressures there comes in the difficulty of strength of metal to withstand the excessive stress, and the friction at bends and leakage at joints give rise to serious drawbacks.

However, the diameter of the pipe is of still greater importance, for it is clear that on doubling the diameter the waste of power is reduced to

$$\frac{1}{2^5} = \frac{1}{32} \text{ of the original amount.}$$

BEST PRESSURE AND SIZE OF PIPE TO USE.

Now, the practical question arises, when we want to transmit a certain amount of power, what is the most economical diameter for hydraulic pipes to convey pressure-water, or what is the best pressure and the best diameter of pipe to employ?

For instance, suppose the *pressure* is given, and the *horse-power* put into the pipe, how does the best diameter of pipe depend on these two things?

The price of one horse-power per hour in pressure-water varies greatly with the locality. It may be extremely low where a waterfall is convenient, and the natural fall of water in rivers utilised, as is the water of Lake Geneva flowing past the town in the Rhone. But in large towns in this country it will not be far wrong to take the cost of 1,000 gallons of water at 700 lb. per square inch at about 2s. This estimate includes interest and all outlay except that for pipes. This amounts to about 3d. per hour per horse-power, or £110 per annum for 1 horse-power day and night.

Assume also that a cast-iron pipe 6 inches in internal diameter costs about 21s. per yard when laid in the street, including joints, etc., but leaving out excavation and repair of roadway. Allow 12 per cent. per annum for interest on capital, depreciation, etc., we find that the *total loss* in pounds sterling (£) per annum for every foot of pipe may be expressed as the sum

$$= \text{power lost} + \text{interest, etc.}$$
$$= 110 \times \frac{\cdot 00374P^3}{p^3d^5} + \frac{\cdot 12p}{3000 - p}(\cdot 108 + 4{\cdot}344d^2).$$

Now, if we give p any convenient value, it is easy to find the corresponding value of d which will make this expression for the total waste a minimum.

Thus, if $p = 700$ lb. per sq. in., the best diameter is
$d' = \cdot 079P^{\frac{3}{7}}$ feet;
and if $p = 1{,}400$ lb. per sq. in., the best diameter is
$d' = \cdot 049P^{\frac{3}{7}}$ feet.

By using the above formulæ and data the reader may now compile tables showing the horse-power lost in the transmission of power over different distances by water at high pressure when using different sizes of pipe.

EXAMPLE 3.—Suppose 1,000 horse-power is given to water at a pressure of 1,400 lb. per square inch at Nottingham, and that the water comes along a 6-inch pipe to London. If the total length of pipe is 150 miles, how much power is lost in coming? Again, if the pressure of the water supplied were 700 lb. per square inch, what horse-power would be lost in coming, and how much of the power would be available at London?

ENGLISH.—XXVII.

[Continued from p. 123.]

AGREEMENT.

THE preceding lessons have had for their object to make the student thoroughly familiar with the elements which enter into the composition of the English language. Our business now is to take them and put them together. We began our English lessons with some account of the Simple Sentence. We shall now amplify what we stated in our first lesson. If anything you have already learnt is repeated, you will understand that it is of sufficient importance to be impressed upon you a second time.

The rules which govern the construction of words into sentences form, as you have, no doubt, already learnt, that part of grammar which is known under the name of SYNTAX. The word is composed of two Greek roots, namely, σύν (sune), *with*, and τάσσω (tas'-so), *I arrange*, and so denotes a systematic arrangement of words.

Take this sentence and study it—

The sick man drinks pure water copiously.

What we now wish you to ascertain is, whether the proposition is in its simplest form. In order to ascertain this, you must distinguish between what is essential and what is not essential in the sentence. Take then word after word, and put the question, Is this essential? If not, strike it out, and strike out every word until you have reduced the proposition to its simplest form—that is, the form a deviation from which would involve no sense.

The. Is this essential? Yes, because some particular man is intended.

Sick. Is this essential? No, because the omission of the word modifies, but does not destroy the statement.

Man. Is this essential? Yes, because *man* is the subject of the proposition.

Drinks. Is this essential? Yes, because *drinks* declares what *the man* does; he drinks, and does not spin.

Pure. Is this essential? No; for though *pure* tells what sort of water the man drinks, yet the proposition is not destroyed by its omission.

Water. Is this essential? Yes, because *water* tells us what the man drinks; he drinks water, not wine.

Copiously. Is this essential? No; *copiously* does indeed refer to the amount of water which the man drinks, but its omission by no means destroys the sentence.

Thus, then, we have the proposition reduced to this form—*The man drinks water.*

By a second process of a similar kind, the proposition may be still more simplified.

Let it be supposed that you wish to have and contemplate the idea of water being drunk, in its most elementary form, then you do not need the article *the*; accordingly, the proposition now assumes this form—*Man drinks water.*

A third process of simplification brings the sentence to these two words, *Man drinks*, which set forth the simplest statement you can make on the subject. Remove the word *man*, you have no sense; remove the word *drinks*, you have no statement. Consequently, the original proposition, when reduced to *man drinks*, is in its simplest form.

Such, then, is the form to which all propositions or sentences may be reduced. What does the form involve? Here are two words. Those two words you recognise as a noun and a verb, the one denoting a being and the other an act. Being and doing are the great facts with which all science is concerned, and the relation of being to doing, so far as the utterance of that relation is concerned, is the affair of the grammarian. The simplest proposition consists of a noun and a verb so related, that what the verb declares is declared of the noun which is the subject of the proposition.

Agreement.—This, the simplest form of a proposition, may undergo modifications. You may change the subject: for instance, you may make the singular *man* into the plural *men*; but if you make this change, you must also change the verb, substituting *drink* for *drinks*. Here you see an instance of grammatical agreement. *Man drinks, men drink;* these pairs of words severally agree, but in *men drink* and *men drinks* the pairs do not agree. Hence you learn that *a singular noun requires a singular verb, and a plural noun requires a plural verb.*

The English language, having but few inflections, cannot show many examples of grammatical agreement. You have already learnt that in Latin an adjective agrees with its noun in number, gender, and case. In English the adjective is invariable, and so, though it *logically* agrees with its noun, it does not do so grammatically; that is to say, it undergoes no change of form.

Sentences may be either affirmative, negative, interrogative, or interrogative negative; for example:—

Affirmative.	I love my father.
Negative.	I do not love my father.
Interrogative.	Do I love my father?
Int. Negative.	Do I not love my father?

DEPENDENCE.

Dependence or Government.—There is another relation which it is necessary to understand. We

mean the relation of dependence. When we say, *The man drinks* WATER, we state a proposition in which a noun, or object, appears in a state of dependence; the noun *water* is dependent on the verb *drinks*.

This dependence is a logical dependence, a dependence in thought and not in form. This you may see if, changing the form of the sentence, you make *water* the subject of the proposition; thus, THE WATER *is drunk*.

Water, then, remains the same, whether it is a subject or an object. Consequently the agreement is not in form, as there is no change of form to meet a change in sense.

In sense, however, *water* in the former sentence is dependent on *drinks*. It is, in fact, that on which the action of the verb falls.

Hence it is the thought you must consult to know whether a noun is or is not an object. This remark is necessary, because, for want of inflections, ambiguity may arise, as in cases when the subject may become the object, and the object the subject; for example—

Subject.		*Object.*	*Subject.*		*Object.*
The man	strikes	the boy.	The boy	strikes	the man.

These two statements are the reverse of each other, and observe that the reversal is made by a mere change of position; *man*, which in the first sentence is the subject, becomes in the second sentence the object, by being put after the verb. You thus learn how important a part position plays in English grammar. It will be very useful for you to compare the Latin usage in this respect with the English. In Latin, the position of the words in a sentence is not of the same importance, because a grammatical inflection makes it quite plain which is object and which subject.

In the instances above considered, the dependence is that of a noun on a verb. There is another kind of dependence; that of a noun on a preposition, as seen in the following sentence: *The water is drunk* BY THE MAN. Here *the man* is in sense dependent on the preposition *by*.

Not only nouns, but verbs also, are dependent on propositions; thus, *The physician* ORDERS *the man* TO *drink water*; where in sense, or logically, *drink* depends on *to*.

The sentence presents a third case of dependence, for you see that the verb *drink* is in sense dependent on the verb *orders*.

Position here, too, is of consequence, for the dependent verb *drink* comes after *orders*, and after *to*; in no way could *drink* precede *to*, and scarcely could *orders* follow *drink*. Instances of dependence may also be considered as instances of government.

One word is said to be governed by another when the former is dependent on the latter; as, *The man* DRINKS *the water*—where *water* is governed by *drinks*, because *water* is dependent on *drinks*.

Under the heads of AGREEMENT and DEPENDENCE (or government) may all the facts and laws of grammar be arranged. You see the two set forth as they appear in this sentence:—

$$\text{The}\ \overbrace{\qquad}^{\textit{Agreement.}}\ \text{man}\ \overbrace{\qquad}^{\textit{Agreement.}}\ \text{drinks}\ \overbrace{\qquad}^{\textit{Dependence.}}\ \text{water.}$$

But here is an instance of agreement of which we have not spoken, that between the article and the noun *the man*; *the* and *man*, referring to the same object, agree in sense. We subjoin them:—

Instances of Agreement.	*Instances of Government.*
The article and the noun.	The object and its verb.
The adjective and the noun.	The noun and the preposition.
The verb and the noun.	A verb and a preposition.
	A verb and a verb.

Verbs of Different Kinds.—The government of a noun by a verb takes place only when the verb is transitive. A transitive verb is a verb the action of which passes from the subject to the object. Thus, in the sentence, *The man drinks water*, the act denoted by the word *drinking* passes directly from *man* to *water*. Verbs that have an object directly dependent on them are called *transitive*, that is, passing over (from Lat. *trans*, "over," and *eo*, "I go").

In order to make our meaning plain, we will recapitulate what you have already learnt concerning the various classes of verbs.

Transitive verbs have for their opposite verbs *intransitive*; that is, verbs the action denoted by which does not extend to an object, but remains confined to the subject. *Sleeps*, in the sentence, *The man sleeps*, is an intransitive verb.

Intransitive verbs may appear either with a personal subject, as in the last sentence, or without an impersonal subject, as in *It rains*.

Transitive verbs may exist in two forms, as:—(1) ACTIVE. *The man drinks water*. (2) PASSIVE. *The water is drunk by the man.*

These two forms are commonly called *voices*. In the first the verb is said to be in the *active voice*; in the second the verb is said to be in the *passive voice*. A transitive verb is in the active voice when it has a subject and an object. A transitive verb is in the passive voice when it has only a subject. In the passive voice the object of the active verb has become the subject. Only transitive verbs can exist in the passive form.

We have endeavoured to show you that the form "man drinks" is the simplest sentence that can be constructed. A sentence equally simple can, however, exist in another shape: as, *The man is good.*

In the analysis of this sentence, we have to introduce and explain a new term or two.

You already know that *the man* is the subject of the verb *is*, but what is *good*? The word *good* is an adjective, or it may be called an attributive, because it assigns the attribute or quality of the noun *man*. This attribute is connected with the subject *man* by means of the verb *is*. A verb so connecting an attribute with a subject is called a *copula*, or link: and that copula in union with the attribute is termed the *predicate*. This name is given to the united copula and attribute, because when so united they predicate or declare something of the subject. These facts may be exhibited thus:—

SUBJECT.	PREDICATE.	
	Copula.	*Attribute.*
(1) The man	is	good.

SUBJECT.	PREDICATE.	
	Verb.	*Object.*
(2) The man	drinks	water.

In the second sentence, you see *drinks water*—that is, a verb and its object—is the predicate; for it is they which there predicate or declare something of the subject.

In the case of intransitive verbs, the predicate has no attribute, as exhibited in this sentence:—

SUBJECT.	PREDICATE.
The boy	runs.

A yet more abstract form of a simple sentence is found in this example:—

SUBJECT.	PREDICATE.
The man.	is.

where *is* is the predicate to the subject *the man*. Here, however, observe that the word *is* is employed in the sense of *exists*, and so is seen to belong to the general class of intransitive verbs.

It may be added that the verb *to be* is sometimes called a *substantive verb*, because it denotes existence in its most abstract form.

Before going further, we may remark here that intransitive verbs are also denominated *neuter* (*neither*) *verbs*, because they are properly *neither* active *nor* passive.

SYNTAX OF THE SUBJECT.

We now proceed to the grammatical analysis of simple sentences considered in their several elements, taking, as the thread of our discourse, the oft-repeated model in its fullest form—

The sick man copiously drinks pure water at the well.

We shall consider what modifications the several parts may undergo, and what instances of agreement or government they involve.

We shall first take the subject, *the sick man*, and then the predicate, *copiously drinks pure water at the well*.

THE ARTICLE.

The subject consists simply of three words. Of these words, the first, *the*, may become *a*: as, *a sick man*. As the sentence stood originally, some particular sick man was designated. Now this determinativeness is lost, and instead we have the statement that a sick man, whoever he may be, drinks, etc.

This want of determinativeness may be increased by substituting the indefinite pronoun *some* for the definite article *the*. Or it may be wholly removed, and an exact determination may be substituted, by putting *this* into the place of *a* or *the*: as, *this* (or *that*) *sick man drinks*.

Of these determinatives some are singular, others plural, and they may be arranged thus:—

DETERMINATIVES.

Singular.	A.	one,	some,	this,	that.
Plural.	—	—	some,	these,	those.

These determinatives are adjectival—that is, they qualify nouns: as, *a man*. Of these adjectival determinatives, *one* and *some* may be used with a substantival force: as—

SUBSTANTIVAL DETERMINATIVES.

"I love boys." "*All* boys?" "No, good ones."
Here are many books; *some* in Greek, *some* in Latin.

These determinatives all agree with their nouns. Thus *a* agrees with *man*; *some* also agrees with *books*, for *some* and *books* are symbols of the same objects.

The definite article is also prefixed to adjectives in the superlative degree, in order to denote the highest possible amount, being thus used intensively: as—

The *most strenuous* exertions will be made.

The indefinite article gives to plurals the force of totality or unity: as—

"Let the damsel abide *a few days*." (Gen. xxiv. 55.)

When *a few* is the subject of the proposition, it has a plural verb: as—

"When a few years *are* come, then I shall go." (Job xvi. 22.)

The repetition of the article with adjectives of dissimilar import requires the verb to be in the plural: as—

The metaphorical and *the* literal meaning *are* improperly mixed.

Here two meanings are intended. But in this example—

The original and present signification *is* retained,

only one signification is meant. We may also say—

The north and south *poles are* wide asunder.

THE ADJECTIVE.

The next word in the subject is the adjective *sick*, which qualifies the noun *man*. As qualification is the attribute of the adjective, it may be called the qualifier, and whatever word qualifies the noun performs the part of an adjective.

Some adjectives may be used as adverbs; that is, some adjectives may qualify verbs instead of nouns. When we say "the house is near," *near* is an adjective. But when we say "he stood near," we use *near* in an adverbial sense.

Participles frequently stand as adjectives: as, the *broken* wheel, the *mourning* city.

Adjectives sometimes appear as nouns. The word *square* is, according to its application, either a noun or an adjective, as appears in these examples:—

Noun.—The general ordered the troops to form a *square*.
Adjective.—A *square* room fails in due proportion.

Adjectives may be made into nouns by means of the definite article: as, *the cowardly*. For example—

The cowardly flee when there is no danger.

It is only when an adjective has acquired a fixed substantival force that it can be preceded by the indefinite article: as—

An *imbecile* should be restricted from doing evil.

It also deserves remark that an adjective converted into a noun by the definite article is used in the plural. Thus we say—

The sick *are* well tended;

but if we want to employ the singular, we must say, not "*the sick* drinks," but "the sick *man* drinks pure water."

Adjectives are generally placed before the nouns which they qualify: as—

"*Miserable* comforters are ye all." (Job xvi. 2.)

But when an adjective is an attribute, and so forms part of the predicate, it stands after its noun: as—

"No hand is wholly *innocent* in war."

The qualified noun is sometimes understood—that is, it has to be supplied from either the sense or the context: as—

"To whom they all gave heed, from *the least* to *the greatest*." (Acts viii. 10.)

In every case the adjective agrees with the particular noun with which it stands connected. When, then, the noun is of the singular number, the adjective is to be accounted of the singular number; when the noun is of the plural number, the adjective is to be accounted of the plural number. Also, the gender of the noun determines the gender of the adjective.

There are pronouns which possess an adjectival force—as, *this* and *that*. *This* and *that* have plural forms; consequently, *this* and *that* undergo a change when they come before plural nouns. For example—

This horse, *these* horses; *that* book, *those* books.

The word *whole*, denoting one object, a unit, cannot, like *all*, be used distributively, and consequently ought not to stand before a plural noun.

As a singular noun requires a singular adjective, so, *vice versâ*, a singular adjective requires a singular noun. Hence we must condemn as ungrammatical the union of adjectives of number (except *one*) with nouns in the singular: as—

INCORRECT.	CORRECT.
Twenty *foot* long.	Twenty *feet* long.
Six *pound* ten *shilling*.	Six *pounds* ten *shillings*.

Adjectives in the comparative degree take *than* after them, as in the following example:—

He is wiser than you.

The sentence is obviously elliptical; if you fill it up, it will stand thus—

He is wiser than you *are*.

Here *you* bears to *are* the same relation that *he* bears to *is*. We mean they are severally subjects to the verbs. Hence arises the ordinary rule that *conjunctions (than* is a conjunction) *have the same case after as before them*. In the following—

I believe him to be wiser than you,

you may be either the subject or the object, according to the construction intended. We will fill up the ellipsis in two ways, and you will see the difference:—

Subject.—I believe him to be wiser than you (are).
Object.—I believe him to be wiser than (I believe) you (to be).

The proper way, then, to ascertain the relation which a noun or pronoun holds after a comparative, is to fill up the ellipsis or supply the words necessary to complete the sense.

Some adjectives, from the nature of their import, do not admit of comparison. If a thing is universal, it cannot be more than universal; consequently, *universal* has no comparative and no superlative. *Perfect* is equally incapable of comparison. The same may be said of *absolute, infinite, interminable, boundless*. Accordingly, it is incorrect to say—

He is *more perfect* than you.

Instead of which you may say—

He is *less imperfect* than you; or,
He is *nearer perfection* than you.

Double comparisons are to be avoided. For example—

INCORRECT.	CORRECT.
Less *nobler* plunder.	Less *noble* plunder.
The *most straitest* sect.	The *straitest* sect.

But all the points of grammar, of which we have given you a brief *résumé*, are treated at greater length in the earlier lessons, and they are only set before you here as a reminder.

GEOMETRICAL PERSPECTIVE.—XI.

(Continued from p. 116.)

PROBLEMS—LVI.—LXII.

SHADOWS OF CURVILINEAR OBJECTS.

PROBLEM LVI. (Fig. 94).—*A globe casts its shadow upon the ground; the sun's rays parallel with the picture at an angle of 45° with the horizon.*

This problem may be done upon the principle of drawing a circle in perspective; thus the shadow produced would be of an elliptical form. From *e*, with *e a* as a radius, draw the semicircle *a d b*: the chord *a b* to be equal to the diameter of the globe. From PS arrange the distance points DE² and DE¹. Refer to Problem XII., Fig. 31, Vol. III., page 341, for the method of drawing the remaining lines, preparatory to drawing a circle in perspective. For the inclination of the sun's rays, draw A B according to the given angle anywhere, either on the HL or the base of the picture.

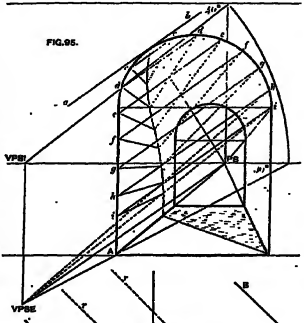


FIG. 95.

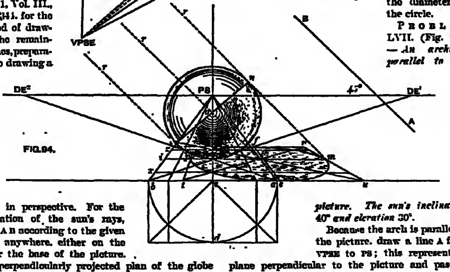


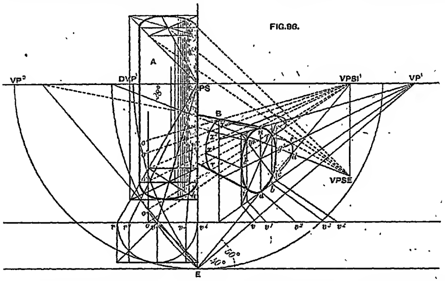
FIG. 94.

The perpendicularly projected plan of the globe would be a circle, and as the line *i k* is the perspective diameter of the circle, and *h* the centre, make *h o* equal to *h i*; and from *o*, the centre of the globe, with the radius *o h*, draw the circle *s h n*. Tangential to the circle *s h n* at *s* and *r*, and parallel to A B, draw the rays *r*, *r*, also the line *r o* through *o* to *k*. Produce *i L* and its parallels from *s*, *z*, *x* indefinitely: through the point *w*, where *i L* produced intersects the ray *r n*, draw *w r* in the direction of PS, also through *p* draw the line *t w* to PS. Draw the diagonals *v w* and *t r*, through their intersection *k* draw the line *c f* towards PS; we shall then have the rectangle in perspective, within which is to be drawn by hand the elliptical form of the shadow as in Fig. 81. For observe, in proportion as the sun's rays are inclined to the plane on which the shadow falls, so will the diameter *h m* become longer than the diameter of the circle.

PROBLEM LVII. (Fig. 95).—*An archway parallel to the picture. The sun's inclination 40° and elevation 30°.*

Because the arch is parallel to the picture, draw a line A from VPSE to PS; this represents a plane perpendicular to the picture and passing through the sun. Draw the line *a b* tangential to the arch and parallel to the line A, also any number of normals anywhere at pleasure, *c c*, *d d*, *e c*, etc.

Commencing at the tangent, the point where the shadow begins, draw lines from it and *c*, *d*, *e*, *f*, etc., to PS, and from the opposite corresponding points in the arch draw lines to VPSE; the intersections of these last with the former will give the points through which to draw the form of the shadow. The shadow appears to be convex, it really is not so; it is only the effect produced from having a front view of it as it lies upon the interior of the perspective projection its form takes that of the object receiving it, and is in this case almost the repetition of a section of the cylinder parallel to the base. We say almost, because the rays of the sun's inclination are not quite parallel with the base of the cylinder. If the rays and the base of the horizontal cylinder had been parallel, then both would have retired to the same vanishing point, and then the shadow of the base would have been a straight



arch. If we had a side view of this shadow, we should then see it was concave.

PROBLEM LVIII. (Fig. 96).—*Two cylinders, one horizontal, the other perpendicular. The base of the horizontal cylinder is at an angle of 40° with the PP. The sun's inclination 50°, elevation 28°. The proportions, angles of sight, etc., at pleasure.*

It will be noticed that we have drawn the semicircle of distance from the PS through E (the position of the eye) *below the* HL; hitherto we have drawn it *above*. It is of no importance on which side of the HL it may be drawn; the process of working is the same in both cases. Our present reason for placing it where we have is for the sake of economising space, and it gives us the opportunity of introducing this convenient arrangement to our pupils. As the bases of both cylinders retire, it will be necessary to construct them according to the rule given in lesson III., Vol. III., page 344, already referred to in Problem LVI. The principle upon which the shadow of the upright cylinder crosses the horizontal one is, that in line, but their not being parallel causes the shadow of the base on the ground to be slightly curved. To draw this curve, the shadow of the base *a b c d e*, lines must be ruled from *a*, the part of the cylinder that is upon the ground, from *b*, the projection of the point *f*, and *c*, the projection of the point *g*, each to VPSI. Rays drawn from *f* and *g* towards VPSE to intersect those lines respectively in *d* and *e* will determine the points through which the curve is to be drawn by hand; the remaining portion of the edge of the shadow from *e* is straight and directed towards the vanishing point of the cylinder VP². In the same way the curve of the shadow *across* cylinder B is not parallel to the curve of the base: therefore, to obtain it, produce the tangent in *h* at the base of cylinder A to the base of the picture in O, draw the perpendicular, and make the distances O o^1, O o^2, etc., equal $v\,v^1$, $v\,v^2$, etc.; rule from each point o^1, o^2 to VPSI, to intersect lines drawn from *i*, *k*, *m*, *n* towards the VP²; through the intersections at $x\,x^1$, etc., draw the curve of the shadow by hand. The shadow

which falls on the ground beyond the cylinder B will not need an explanation. The mode of construction has been already given in lesson XVII.

PROBLEM LIX. (Fig. 97).—*A column supporting a horizontal square slab at right angles with the picture plane. A pole leans against the wall behind, and casts its shadow on the column. Sun's inclination 40°, elevation 35°.*

the shadow of c at b. The same process from d will give the shadow of d at e; any other point in the course of the shadow may be thus projected; through these projected points draw by hand the curve of the shadow. For the shadow of the column and the slab on the ground, draw a line from DE¹ through the centre of the base of the column to h; draw the perpendicular line $f\ h$, h will be the

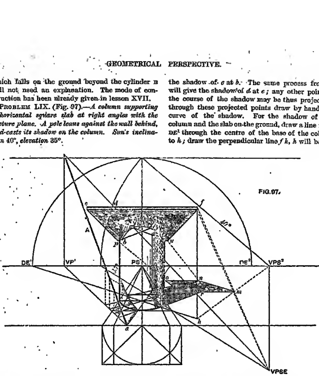


FIG. 97.

Shadows on curved surfaces are for the most part produced by projecting lines. Let A be the pole; mark any number of points in the pole, at any distance apart, and draw perpendicular lines from these points to intersect the horizontal projection of the pole, a VP¹. From the points of intersection draw lines towards VPSI as far as the base of the column; afterwards they must be taken perpendicularly to meet the rays drawn from the points in the pole to VPSE. Where these rays intersect the perpendiculars, will be found the points of the shadow of the pole projected on the column, and through which the curve of the shadow must be drawn by hand. The same principle obtains with regard to the shadow of the slab on the column of which b is the shadow of the corner c. Draw a line from c to VPSI to the edge of the column beneath the slab, from which draw a perpendicular line to cut the sun's rays from c to VPSE. The intersection of these two lines will give horizontal projection of the point f; draw a line from h to VPSI, then rays drawn from f to VPSE intersecting h VPSI will give the shadow of f at m; draw a line $m\ r$ parallel to the base of the picture to intersect a line drawn from the front edge of the base of the column to VPSI; draw the ray $u\ n$ towards VPSE to intersect a line drawn from m to PS, n will be the shadow of u; draw the ray $p\ o$ towards VPSE to intersect a line drawn from n parallel to the picture or to HL, o will be the shadow of p; draw a line tangential to the opposite edge of the base of the column to intersect $o\ s$, drawn from PS; this will complete the outline of the shadow of the column and slab.

SHADOWS CAUSED BY ARTIFICIAL LIGHTS—CONCLUSION.

We now intend to prescribe rules for projecting shadows caused by an artificial light, as from a lamp or candle. If the pupil has carefully studied

the previous lessons upon shadows projected by the sun, he will find the construction of those caused by this light very similar. The principal difference between candle-light shadows and sun shadows is found to be in the position of the luminary. A candle placed on a table diffuses its light in every direction, and consequently the rays do not proceed as those of the sun, which, from its great distance from the earth, are considered to be parallel, although radiating from one common centre; besides, the source of light being very near the objects, when in a room, the shadows for the most part are much more extended, and appear larger than the objects which cause them. However the forms and positions of objects may vary, as well as the surfaces upon which the shadows are cast, the principles that guide us in projecting them are the same as those which belong to sun shadows. The seat or base of the source of light must be first determined, afterwards the extent and direction of the shadows will be found by drawing lines from the base of the light, which is upon the ground, to intersect rays drawn from the luminary through the angles and extremities of the object. This is the first and most simple rule, and is illustrated by Fig. 98. *a* is the source of light, and *o* is the horizontal projection or base of the light; if rays are drawn from the light through the angles of the table *b*, *c*, *d*, *e*, and other lines drawn on the ground plane from *o*, the foot of the light, the intersections of these two sets of lines will give the projection of the shadow at *g*, *h*, *m*, *n*. Here we shall see that the extent of the shadow is greater than the

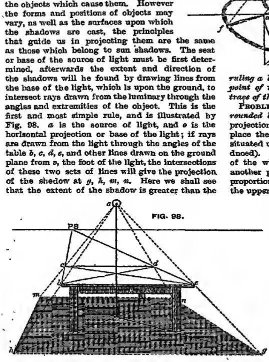


FIG. 98.

top of the table which projects it. This very simple rule is the starting point for the rest; and where the forms and positions of objects vary, we shall find it necessary to employ those rules which guide us in projecting sun shadows, when again the trace of the plane of shade must be drawn by

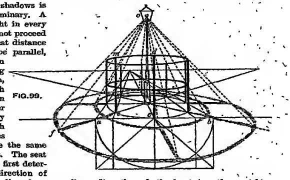


FIG. 99.

ruling a line through the luminary, the vanishing point of the plane receiving the shadow, and the trace of the plane which casts the shadows.

PROBLEM LX. (Fig. 99).—*A street lamp surrounded by an iron fence.* Draw the perspective projection of a circle according to the diameter *a b*; place the posts at pleasure (in the figure they are situated upon the lines by which the circle is produced). The post *c d* represents the given height of the whole, through the top of which is drawn another perspective circle, in order to obtain the proportionate heights of the remaining posts, and the upper edge of the fence. From the foot of the lamp-post lines are drawn outwardly to meet the rays drawn from the light in the lamp at *e*, and through the top of each post as *e f*; *c f* is the shadow of the post *c m*. The same process is to be observed with the rest; through the extremities of the shadows of the posts draw another circle in perspective to represent the shadow of the upper ring of the fence. The projection of the shadow of the ring midway between the ground and the tops of the posts is but a repetition of the upper one.

PROBLEM LXI. (Fig. 100).—*A pole is leaning against a wall* A, *against which it casts part of its shadow, and the remainder upon another wall* B, *at right angles with* A. *Let* D *be the source of light.* Draw an indefinite perpendicular line from PS. Draw *c e* to represent the inclination of the pole. From the point *d*, at the intersection of *c* PS with

the base of the wall A, draw the perspective line *d b*: *c b* will be the representation of the pole. Rule an indefinite line from PS through the base *m* of the luminary; also a line, the trace of the plane of shade, from *c*, the VP of the pole, through D to *f*. From the point *h*, where the line through the shadow from the top of the ladder at *c* on the opposite wall C, is the same as that of the pole; for this portion VP³ is the vanishing point on the trace of the plane of shade; VP² is the vanishing-point of the door—that is, for the lines *b c* and *d c*. To find the vanishing point of the shadow on the

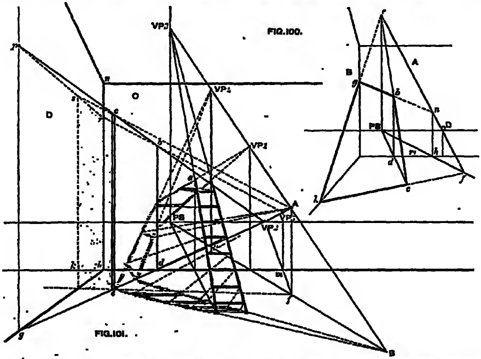


FIG. 100.

FIG. 101.

base of the luminary vanishes at PS, and intersects the base of the wall A, draw a perpendicular line to cut the trace of the plane of shade in *z*; draw from *n* through *b* to *g* on the intersection of the two walls; through *g*, directed from *e*, draw *g k*; *k* will be found to meet a line drawn from *f* through *c*; *c k g b* will be the shadow of the pole.

PROBLEM LXII. (Fig. 101).—*A ladder leaning against a wall casts its shadow partly on the wall* C; *it is continued on an open door, not perpendicular with its connecting wall; and lastly upon the ground. Project also the shadow of the door. Let* A *be the source of light.*

After the last problem relating to the pole, it will not be difficult to understand the shadow from the ladder in this case; the position of the door will cause some difference in the course of the shadow which falls upon it. The method of projecting the door, draw a perpendicular line to meet the trace of the plane of shade from *e*, where the vanishing line from the bottom of the door intersects PS B; this will produce VP⁴; lines drawn upon the door in continuation of those from *e*, and directed by VP⁴, will be those of the shadow required. And lastly, lines drawn from B through the foot of the ladder will unite with those on the door at the base. To project the shadows of the steps, draw lines from A, the luminary, through the extremities of each step to meet the shadow lines of the sides of the ladder between which the shadows will be projected. To produce the shadow of the door on the wall D to the left, let *h n* be the angle of the wall, and *k g* its base. Draw *f e* produced to *k*; from *k* also an indefinite perpendicular line through *s*; the position of *s* will be explained presently; produce *d e*, the base of the door, directed by its

vanishing point VP², to intersect the wall D at *g*; draw *c b* to *p*, also the perpendicular line *g p*, then the plane of the door will intersect the plane of the wall in *g p*; join *f*, the base of the luminary, with the vanishing point of the door VP²; this will intersect the base of the wall at *m*; draw a perpendicular line from *m* to VP⁵; this will be the vanishing point for the shadow of the door on the wall C. Directed by VP⁵, and through *b*, draw *b r*; also, directed by *p*, draw *s r*. The portion of the shadow *r s k h* will be on the wall D, and the remainder on C.

In these lessons on Perspective we have endeavoured to explain principles, rather than multiply examples; and in order to carry out our intention, the subjects we have chosen have been those that would enable us to employ rules having a general application. That which is of the first importance in Perspective, and may be considered the foundation upon which the whole science is built, is the projection of a point, or a series of points, which, when united by lines, represent, according to the positions of the points, the object required; consequently there can be but few especial rules. The infinite variety of objects the draughtsman has to represent, with their numberless forms and positions, may sometimes perplex him; but however complicated they may be, experience will teach him that when in difficulties he must invariably fall back upon first principles.

We have thought it advisable, in stating our problems, to give them under relative proportions, and to employ a scale of measurement. Practically this will be found to be of great advantage, as otherwise we should have given but abstract forms, which might assist in explaining a theory, but for any useful purpose would in a great measure frustrate the end we have always kept in view—namely, that of making these lessons really serviceable to our pupils.

In conclusion, for whom, it may be asked, are these lessons in Perspective intended? Are they to be studied only by architects and mechanical draughtsmen? Undoubtedly these have the first interest in them, as they are thus provided with a means for rendering their work more truthful and intelligible. An architect and a painter may, in many respects, be famous in their respective professions; but if they are ignorant of the first principles of design, which are founded upon the indisputable rules of Perspective, it is hardly possible that they can have that full power and freedom of expressing their ideas which is so essentially necessary for the success of their work. To the architect a perspective drawing of a building from some particular point of view, showing how it will appear when erected, will answer in every respect the purpose of a model; while an intimate acquaintance with angular perspective will relieve the painter from the old, worn-out, and only resource of those who understand but one vanishing point, the point of sight. But there are others who have no professional necessity for studying Perspective, to whom a knowledge of its principles is as important as it is to those who are called upon to practise it; believing it to be, as we most certainly do, one of the most necessary and important chapters in the grammar of art. No one will venture to maintain that a thorough command of a language can be acquired without a very close study of its construction, knowing full well what the results would be; and for the same reason it would be dangerous for anyone to pass judgment upon works of art, if ignorant of the principles of that art. How many there are who do this, and give their opinions in the most self-satisfied way on points of art of all sorts! But if we mention only one inducement out of many we might propose, for studying Perspective as it ought to be studied, *practically*, it would be that it enables us to understand some of the beauties of art, to know its capabilities, and to enter into its enjoyments.

GERMAN.—XXVII.

[*Continued from p.* 121.]

Hören, Zu Grunde gehen, ETC.

Hören (to hear), followed by auf with an accusative, signifies "to listen to," as:—Er hört auf das, was ich ihm sage, he listens to what I tell him.

Hören, however, when connected with auf as a mere *prefix*, signifies "to cease," "to discontinue," as:—Es hört auf zu regnen, it stops raining (ceases to rain); Der Regen hört auf, the rain ceases.

Aber, in the phrase Hunderte und aber Hunderte, Tausende und aber Tausende, etc., signifies "Yet again, yet more, still other." So, also, O weh und aber weh dem Mann, O woe and yet again woe to the man.

Zu Grunde gehen, "to go to the ground *or* to the bottom"—that is, "to sink," "to founder"—has hence the general signification, "to go to ruin *or* be destroyed." So, also, Zu Grunde richten, "to destroy," "to ruin," etc., as:—Das Schiff ist mit Mann und Maus zu Grunde gegangen, the ship, with man and mouse, has perished (gone to the bottom); Unvorsichtige Speculationen haben den Kaufmann zu Grunde gerichtet, imprudent speculations have effected the ruin of the merchant.

EXAMPLES.

Höret auf, des Lebens Teppich vor mich auszubreiten, ich — Cease to spread life's carpet out before me;

bin elend und gefan'gen (Schiller).	I am miserable and imprisoned.
Sobald' er dieses sah, hörte er auf zu spielen.	As soon as he saw this, he ceased to play (stopped playing).
Liebig gehört' zu den gelehr'testen Männern Deutschlands.	Liebig belongs to (is among) the most learned men of Germany.
Er ging nicht eher aus, als bis er eine Stunde gele'sen hatte.	He did not go out before (till) he had read an hour.
Der rus'sische Feldzug rich'tete die "Grande Armée" (wie man sie zu nennen pflegte) zu Grunde.	The Russian campaign ruined (destroyed) the "Grand Army" (as it used to be called).
Bei dem rus'sischen Feld'zuge ging die "Grande Armée" zu Grunde.	In the Russian campaign the "Grand Army" was destroyed.
Tau'sende und aber Tau'sende kamen um ihr Leben.	Thousands upon thousands lost their lives.
Als ich ankam, las er eben meinen Brief.	As I arrived he was just reading my letter.
Das gereicht' ihm zur großen Ehre.	That redounds greatly to his honour.

VOCABULARY.

A'bendbrod, *n.* supper.
Breslau, *n.* Breslau.
Dulden, to bear, suffer, tolerate.
Erle'gen, to slay, kill.
Faustrecht, *n.* club-law, sword-law.
Gebrauch', *m.* usage, custom, fashion.
Gereichen, to redound, turn to, conduce.
Grab, *n.* grave.
Habsburg, *n.* Habsburg (original house of the imperial family of Austria).
Hafen, *m.* harbour, port.
Lächeln, to smile.
Landen, to land, come to shore.
Linde, *f.* linden-tree.
Mit'tagsmahl, *n.* dinner.
Osten, *m.* East.
Rath, counsel. Dazu kann Rath werden, that may be done, *or* it may happen.
Re'gensburg, *n.* Ratisbon.
Reich, *n.* empire, kingdom, realm.
Reichstag, *m.* imperial diet, diet.
Schande, *f.* shame, disgrace, infamy.
Segel, *n.* sail.
Ta'gesgeschäft, *n.* business of the day.
Ufer, *n.* bank, shore.
Verrich'ten, to do, perform.
Verschwenderisch, prodigal, lavish, profuse.
Versin'ken, to sink.
Verza'gen, to faint, lose courage.
Zwist'igkeit, *f.* discord, dissension, quarrel.

EXERCISE 172.

Translate into English:—

1. Als Rudolph von Habsburg Kaiser von Deutschland geworden war, hörten die innern Zwistigkeiten und das sogenannte Faustrecht in diesem Reiche auf. 2. Nachdem sie einige Hirsche erlegt hatten, hörten sie auf zu jagen. 3. Es hört auf zu regnen, und wir können nun unsere Reise weiter fortsetzen. 4. Mein Bruder ist zu Hause, er liegt schon acht Tage zu Bette. 5. In Deutschland sind andere Sitten und Gebräuche, als in Amerika. 6. Zu Regensburg wurden in der letzten Zeit die Reichstage gehalten. 7. Die hohe Schule zu Breslau gehört zu den besten in Deutschland. 8. Als wir hinkamen, speisten sie gerade zu Mittag. 9. Sie pflegten nicht eher ihr Abendbrod zu essen, als bis sie alle Tagesgeschäfte verrichtet hatten. 10. Unter einer alten Linde, welche in dem Hofe stand, hielten sie im Sommer, bei schönem Wetter, ihr Mittagsmahl. 11. Als die Cholera in Paris herrschte, starben Tausende und aber Tausende an derselben. 12. Die Soldaten ziehen zu Felde. 13. Bei dem letzten Sturme sind mehrere Schiffe zu Grunde gegangen. 14. Der Bettler geht von Thür zu Thür, und von Dorf zu Dorf. 15. Das gereicht mir zur Ehre, ihm zur Schande 16. Mir zu Gefallen können Sie es thun. 17. Der Feind steuert mit allen Segeln nach Osten zu. 18. Das ist für ihn zu gut. 19. Ich bin nur zu gewiß, daß es so kommen wird. 20. Es kann auch dazu Rath werden, wenn wir erst unsere eigenen Angelegenheiten geordnet haben werden. 21. Das Leben ist, Freund, ein ernstes Geschäft—dulde kein Ungemach; so nur wird dir die Reise sanft. 22. Endlich landest du doch sicher am Ufer, in deinem Hafen, er heißt das Grab. 23. Er hat sich und seine Freunde zu Grunde gerichtet. 24. Er hat bei diesen Arbeiten seine Gesundheit zu Grunde gerichtet. 25. Nelson richtete die französische Flotte zu Grunde. 26. Wenn er nicht vorsichtig ist, so kann in kurzer Zeit sein ganzes Geschäft zu Grunde gehen.

EXERCISE 173

Translate into German:—

1. Are you listening to what I tell you? 2. Yes, I am listening to what you say. 3. Do you think that he will listen willingly to that proposal? 4. If you listen to what the teacher tells you, you will acquire knowledge. 5. Can we remain with you until the storm has ceased? 6. As soon as the rain ceases, we shall continue our journey. 7. As soon as we saw our teacher, we stopped playing and began to write. 8. Hundreds upon hundreds lost their lives by the revolution in France. 9. After his imprudent speculation had ruined him, he became more careful. 10. It redounds to the honour of a king to govern his dominion in peace. 11. Do not despair when fortune does not smile on thee, or even when thou art sunk in the deepest misery; for it may happen, ere thou thinkest it, that thou mayest be providentially disburdened of all thy troubles.

Werth, Auskommen, ETC.

Werth (worth), like its equivalent in our language, is used in designating the value of things, as:—

Dieses Pferd ist drei hundert Gulden werth, this horse is worth three hundred florins. When, however, the amount of one's wealth is referred to, some phrase like the following is employed:—Er hat ein Vermögen von zehn Tausend-Gulden; or, Er hat zehn Tausend Gulden im Vermögen, he is worth ten thousand florins.

Auskommen (a coming *or* getting ont), with haben, forms the phrase, Ein Auskommen haben, "to have a competency *or* subsistence," as:—In diesem Lande hat der Arbeiter ein gutes Auskommen, während er in den meisten Ländern Europa's nur ein nothdürftiges hat, in this country the labourer has a good subsistence, while in (the) most countries of Europe he has only a scanty (one).

Unterkommen = "coming under"—that is, "a lodging," "a shelter;" also, "an employment," as:—Wir suchten in irgend einem der vielen Gasthäuser dieser Stadt vergebens ein Unterkommen, we sought in vain, in any one of the many inns of this town, a shelter; Der Fleißige findet überall ein Unterkommen, the industrious finds everywhere omployment.

EXAMPLES.

Ein kluger Feldherr gönnt seinen Solda'ten zuwei'len eine Erho'lung	A judicious general sometimes grants his soldiers (a) recreation.
Einmal hat der Schiffer eine ru'hige, dann wieder eine stür'mische Reise.	At one time the mariner has a quiet (pleasant), then again a stormy, voyage.
Er hat kein Vermö'gen dazu, um diesen Aufwand lange Zeit bestrei'ten zu können.	He has no fortune by which (thereto) to be able (for a) long time to afford this expenditure.
Weisheit ist mehr werth, als Reichthum.	Wisdom is more valuable (worth more) than riches.
In der Schweiz hat der Bauer ein bes'seres Aus'kommen, als in dem grö'ßeren Theile Ita'liens.	In (the) Switzerland the peasant has a better subsistence than in the greater part of Italy.
Bei Einbruch der Nacht suchte er in einem kleinen Örtchen ein Un'terkommen.	On the approaeh (invasion) of the night, he songht shelter in a little hamlet (little place).
Der Kaufmann hat dem Capitän' bereits' die Fahrt bezahlt'.	The merchant has already paid the captain (for) the passage.
Mich hat herzlich verlangt', das O'sterlamm mit euch zu essen (Lucas xxii. 15).	I have heartily desired to eat this passover with you (Luke xxii. 15, marginal reading).
Das verlas'sene Kind verlangt' nach seiner Mutter.	The forsaken child longs for (after) its mother.

VOCABULARY.

Eins, one thing.
Erho'lung, *f.* refreshment, recreation.
Fort'gehen, to go away.
Gönnen, to grant, favour, permit.
Hernie'derkommen, to come down.
Kreis, *m.* circle, sphere.
Manchmal, often, frequently, sometimes.
Menschlich, human, founded in hnman nature.
Nachsicht, *f.* forbearance, indulgence.
Noth'dürftig, scanty, necessitous, needy.
Schein, *m.* shine, light.
Stören, to trouble, disturb.
Trost, *m.* consolation.
Trotz, in defiance, in spite of.
Unmög'lichkeit, *f.* impossibility.
Un'terkommen, to find employment, shelter, etc.
Verle'ben, to live, pass, spend.
Verzei'hung, *f.* pardon, forgiveness.
Vor'fallen, to happen.
Warnen, to warn of, admonish against.

EXERCISE 174.

Translato into English:—

1. Es giebt im menschlichen Leben zuweilen trübe Augenblicke. 2. Man muß zuweilen dem Geiste eine Erholung gönnen. 3. Er ist schon manchmal hier gewesen. 4. Schon manchmal habe ich dieses gesagt. 5. Manchmal mißlingt es auch. 6. Es ist jetzt keine Zeit dazu, spazieren zu gehen. 7. Er hat heute noch hinlängliche Zeit dazu, diese Arbeit zu vollenden. 8. Er hat an einem andern Tag mehr Zeit, dich zu besuchen. 9. Dieses Haus ist tausend Thaler werth. 10. Mein Rock ist zehn Thaler werth. 11. Jener Mann besitzt funf hundert Thaler. 12. Er besitzt zehn tausend Thaler. 13. Diese Familie hat ihr gutes Auskommen. 14. Jener arme Taglöhner hat nur ein nothdürftiges Auskommen. 15. Es kamen so viel politische Flüchtlinge an, daß sie nicht alle unterkommen konnten. 16. Die Soldaten fanden alle in den Scheunen und Ställen der Bauern ein Unterkommen. 17. Gestern habe ich dem Kaufmanne seine Rechnung bezahlt. 18. Er hat dem Schneider den Rock noch nicht bezahlt. 19. Er vergaß dem Schuhmacher die Stiefel zu bezahlen. 20. Der Kranke verlangt ein Glas Wasser. 21. Mich verlangt zu wissen, was an der Sache ist. 22. Mich verlangt eine heitere Stunde im Kreis der lieben Meinen zu verleben. 23. Ich verlange das Buch, das dort liegt. 24. Eins bitte ich dich: sei vorsichtig in der Wahl deiner Freunde. 25. Der Mann bat um Geduld und Nachsicht. 26. Da er ihn um Verzeihung bat, so konnte er nicht länger zürnen. 27. Ich bitte Sie um ein Glas Wein.

EXERCISE 175.

Translate into German:—

1. My house is worth a thousand francs, but that of my brother fifteen hundred. 2. That banker is worth a thousand pounds more than that sum. 3. Contentment is of greater value than all the riches of the world. 4. We could not anywhere find shelter on our arrival in America, as all the inns

were full. 5. Everyone who goes to Australia may find employment. 6. Those who have a scanty competency are sometimes the tools of the greatest crimes. 7. My brother bids me to be patient and forbearing. 8. He seeks my forgiveness, and therefore I cannot longer be angry with him. 9. Necessity requires that we should sometimes grant our body relaxation. 10. As he forgot to pay for his coat, the tailor requested him to pay.

Bemühen, Zeitvertreib, ETC.

Bemühen = "to trouble." Sich um Etwas, or für Jemand, bemühen, "to give oneself trouble about," "to take pains," "strive about anything *or* for anyone," as:—Darf ich Sie bemühen, mir das Buch zu reichen? may I trouble you to reach me that book? Du bemühst Dich zu viel um eine so geringe Sache, you trouble yourself too much about so trifling a thing; Ein Freund sollte sich für einen Freund bemühen, a friend should take pains for a friend: Es giebt gewisse gutmüthige Leute, die sich mehr für Andere, als für sich selbst bemühen, there are certain good-natured people who take more pains for others than for themselves.

Zeitvertreib (from Zeit, *time*, and vertreiben, *to drive* or *pass away*) signifies "a pastime," as:—Was ihm Zeitvertreib ist, macht mir Langeweile, what to him is pastime, causes me weariness. Sich die Zeit vertreiben, "to spend *or* pass one's time," as:—Wie vertreibt er sich die Zeit? how does he pass his time? Er vertreibt sich dieselbe mit Jagen und Fischen, he spends it (the same) in hunting and fishing.

EXAMPLES.

Zum Zeit'vertreib begießt' sie ihre Blumen im Garten.	For pastime she waters her flowers in the garden.
Durch diese Mit'theilungen machte er seinem gepreß'ten Herzen Luft.	Through these communications he gave his oppressed heart vent.
Rußland hat sich nicht vergeb'lich bemüht', die Bewe'gungen in Euro'pa zu unterdrü'cken.	Russia has not striven in vain to suppress the agitation in Europe.
Die Leip'ziger Messe ist eine der bedeu'tendsten in ganz Deutschland.	The Leipzig fair is one of the most important in all Germany.

VOCABULARY.

Ab'wesenheit, *f.* absence.	Berühmt', famous, renowned, celebrated.	Etwa, about, nearly, perhaps.
Ausbruch, *m.* breaking out, eruption.	Blatt, *n.* paper, leaf.	Fechten, to fight.
Bemer'kung, *f.* remark, notice.	Durch'lesen, to read over, peruse.	Grimm, *m.* fury, rage, wrath.
Leb'kuchen, *m.* ginger-bread.	Scherzen, to jest, joke, sport.	Ver'wagen (sich), to hazard, venture (out)
Nürnberg, *n.* Nuremberg.	Verfol'gen, to pursue, persecute.	Vor'stellen, to represent, introduce, personate.
Revolution', *f.* revolution.	Verfol'gung, *f.* persecution.	

EXERCISE 176.

Translate into English:—

1. Bei dem Ausbruche der Revolution in Berlin wurde bis in die Nacht hinein gefochten. 2 Er gab ihm das Buch mit der Bitte, es rein zu halten. 3. Es ist ihm gestern ein Brief zugeschickt worden. 4. Ich zeigte ihm die neuen Gemälde, die ich auf der Versteigerung gekauft hatte 5. Musik ist sein liebster Zeitvertreib. 6. Er singt, scherzt und lacht zum Zeitvertreib, anstatt sich mit ernsten Dingen zu beschäftigen. 7. Ich gehe oft Morgens, Mittags und Abends spazieren. 8. Sie verfolgten den Feind bis an die Grenzen des Landes. 9. Bis an diese Stelle hatte sie das Buch durchgelesen. 10. Bis an diesen Ort wagten sie sich vor, aber weiter nicht. 11. Er bemühte sich vergebens, die Frage zu lösen. 12. Sie bemühten sich um die Gunst ihres Herrn. 13. Er bemüht sich Reichthümer zu erwerben. 14. Ich bin etwa fünf Jahre hier (in dieser Stadt). 15. Ich bin seit einer halben Stunde hier (in dem Zimmer). 16. Ist Jemand während meiner Abwesenheit hier gewesen? 17. Herr N. war hier und wollte Sie sprechen. 18. Ein Berliner Blatt macht uns folgende interessante Mittheilung. 19. Die Nürnberger Lebkuchen sind durch ganz Deutschland berühmt. 20. Das Heidelberger Faß ist wegen seiner Größe bekannt. 21. Ich empfehle mich Ihnen, mein Herr. 22. Empfehlen Sie mich Ihrer Familie. 23. Er empfahl sich der Gesellschaft 24. Da der alte Jäger seinem Grimm nicht anders Luft zu machen wußte, so schlug er seine Hunde.

EXERCISE 177.

Translate into German:—

1. My friend sent me a book, with the request to peruse it. 2. I have perused your book as far as the second chapter. 3. A parcel was sent to me yesterday. 4. Study is my most agreeable pastime. 5. In the morning I study, and in the evening I teach my scholars. 6. We need not trouble ourselves on account of our friend; he does not need our assistance. 7. During the absence of our teacher we played instead of learning. 8. How long have you been in London? 9. I have been nearly three years here. 10. Was my brother here during my absence? 11. No, he was not here. 12. May I trouble you to write me this letter? 13. A diligent boy strives to acquire knowledge.

TRANSLATIONS FROM GERMAN.

Gotthold Ephraim Lessing was born at Kamenz in 1729. He was educated at Leipzig, Berlin, and

Wittenberg. The greater part of his life was devoted to letters, and he had a profound influence on German literature. He wrote many plays and poems, and was a critic of considerable acumen. He is (and will be) chiefly remembered for his celebrated essay, entitled "Laocoon." He died in 1781.

Der Tanzbär.

Ein Tanzbär war der Kett' entrissen,
Kam wieder in den Wald zurück,
Und tanzte seiner Schaar ein Meisterstück
Auf den gewohnten Hinterfüssen.
„Seht," schrie er, „das ist Kunst; das lernt man in der
Welt.
Thut mir es nach, wenn's euch gefällt,
Und wenn ihr könnt!" „Geh," brummt ein alter Bär,
„Dergleichen Kunst, sie sei so schwer,
Sie sei so rar sie sei,
Zeigt deinen niedern Geist und deine Sklaverei."

. . . .

Ein grosser Hofmann sein,
Ein Mann, dem Schmeichlerlei und List
Statt Witz und Tugend ist;
Der durch Kabalen steigt, des Fürsten Gunst erstiehlt,
Mit Wort und Schwur als Komplimenten spielt,
Ein solcher Mann, ein grosser Hofmann sein,
Schließt das Lob oder Tadel ein?

Gotthold Ephraim Lessing.

KEY TO EXERCISES.

Ex. 166.—1. The robbers seated themselves around a great fire, which they had kindled in the midst of the forest. 2. He took his seat at the table. 3. He got on his horse and galloped out of the town. 4. The dragoons were all on horseback, and waited only for their commander in order to begin the attack. 5. He sat on his throne so gloomy and so wan. 6. We found him sitting under a tree. 7. The visitor asked the innkeeper next morning what he owed. 8. He had to pay a Prussian dollar, or one florin and forty-five kreutzers, for what he had eaten. 9. This man owes me one hundred dollars. 10. After he had spent all his money in foreign countries, he returned home poor and destitute. 11. The soldier ate the food placed before him with the greatest appetite. 12. Are there many who defend the fortress? 13. Yes, there are many, but there might be as many more, still we do not fear. 14. There were about a hundred of them, who, under the command of a young soldier, took the battery by storm. 15. An effeminate man is not fit for any work. 16. This evidence is good for nothing. 17. The Hungarian general voluntarily offered his services to the Turkish emperor. 18. The peasant offered some apples to the exhausted traveller. 19. One often reads in the newspapers that a good opportunity of making one's fortune presents itself. 20. He complains of unreasonableness and harshness. 21. You deny me the liberty to be able to complain to you. 22 He felt, he did not know what, and seemed astonished at this event. 23. He seemed surprised as he saw his friend enter, whom he had not seen for nearly ten years.

Ex. 167.—1. Dieses Messer taugt nichts, geben Sie mir ein anderes. 2. Was Sie gemacht haben, taugt nichts. 3. Wozu taugt ein unehrlicher Mann? 4. Diese armen Leute verzehrten die ihnen vorgesetzte Speise mit dem größten Appetit. 5. Wir lesen in jeder Zeitung, daß Australien eine gute Gelegenheit darbiete, sein Glück zu machen. 6. Wir waren erstaunt, unsern Freund zu sehen, von welchem wir glaubten, daß er in Deutschland sei. 7. Dieser Mann ist mir mehr als zwanzig Pfund schuldig; aber er sagt, er habe mich bezahlt. 8. Ich will Sie bezahlen, aber Sie können nicht beweisen, daß ich Ihnen etwas schuldig bin. 9. Haben Sie heute Ihren Bruder gesehen? 10. Ja, ich sah ihn in unserm Garten unter einem Baume sitzen. 11. Die Soldaten setzten sich zu Pferde, und warteten auf das Signal ihres Anführers, um den Angriff zu beginnen.

Ex. 168.—1. First he took paper and pens, then he sat down to write. 2. He has only just begun to work. 3. It is only just past seven o'clock. 4. This boy is only fourteen years of age. 5. It now began indeed going on very badly. 6. It is half an hour's walk to the next village. 7. This is the nearest way there. 8. I will write to him by the next post. 9. An inconsiderate word is sometimes the immediate cause of quarrel and dispute. 10. My friend comes here next week. 11. He intends to start next year for America. 12. In future years I shall be more careful. 13. Next week I go into the country for a few days. 14. We should think more of the future life than of the present. 15. My future life shall be devoted to you. 16. I fear it will not succeed in this way. 17. He dares more for earthly than for heavenly riches. 18. The active wife attends to her domestic affairs herself. 19. The neighbour took the letter to the post. 20. The errand was punctually attended to by the little boy. 21. The fortress was sufficiently provided with provisions. 22. My brother provided me early with good books. 23. The poor man has six children to provide for.

Ex. 169.—1. Erst werde ich lesen, dann werde ich schreiben. 2. Ich kehrte von meiner Reise erst gestern zurück. 3. Ich werde ihn erst morgen sehen. 4. Ich habe erst die Hälfte meiner Bücher erhalten. 5. Erst sollten wir vermeiden Böses zu thun, und dann Gutes thun. 6. Ich werde wahrscheinlich nächsten Frühling einige Tage auf das Land gehen. 7. Sind Sie hinreichend mit den Ursachen seiner augenblicklichen Abreise bekannt? 8. Dieser Auftrag wurde pünktlich von diesem Manne besorgt. 9. Diese arme Frau hat fünf Kinder zu versorgen. 10. Ich versehe ihn zuweilen mit einem lehrreichen Buche. 11. Nächstes Mal werde ich vorsichtiger sein.

Ex. 170.—1. I wish you a good morning. 2. I have the honour to wish you a good morning. 3. I remember my friends with sincere affection. 4 In times of prosperity he did not think of him, but in the hours of anxiety and distress he remembered him. 5. I intend to go on a journey. 6. I intend to return soon. 7. We intend to go on a journey. 8. You intended to do me mischief. 9. The father intends to agree to it. 10. I did not intend to go there. 11. I am packing my trunk, because I intend in a few days to go on a journey. 12. I am on the point of departing. 13. I am on the point of going out. 14. They conduct the criminal to the place of execution. 15. The duke's son led the troops to the assault himself. 16. He led them to the attack. 17. Russia waged war with Poland. 18. The merchant brings goods to the market. 19. A little child was leading the blind man. 20. Alaric was buried by the Goths in the Busento, after they had first turned off the current. 21. He

guides everyone according to his counsel. 22. He who does not submit to be guided by reason, runs the risk of being led by his passions to ruin. 23. The diligent scholar overtook his comrades in learning the English language, although they had begun to learn it about four weeks sooner. 24. We overtook the friends on their journey, although they went away half an hour earlier. 25. Men do not attain to so great an age nowadays as in former times. 26. At the present day one hears of nothing else but war. 27. At the present day one hears much complaining of bad times.

Ex. 171.—1. Ich wünsche Ihnen einen guten Abend. 2. Ich habe das Vergnügen, Ihnen einen guten Morgen zu wünschen. 3. In der Fremde gedenken wir oft mit Liebe unserer Freunde in der Heimath. 4. Ich gedenke nächsten Monat nach dem Festlande zu gehen. 5. Gedenken Sie lange dort zu bleiben? 6. Nein, ich gedenke nicht lange dort zu bleiben, ich werde bald zurückkehren. 7. Er versuchte seinen Freund bei der Erlernung der deutschen Sprache einzuholen, aber er konnte es nicht, denn sein Freund war zu weit vorgerückt. 8. Gedenken Sie, Ihren Bruder auf seiner Reise einzuholen? 9. Ich holte meinen Vetter nach einer dreitägigen Reise ein. 10. Vor sechs Monaten war ich im Begriffe, nach Amerika zu gehen; nun aber bin ich sehr froh, daß ich in der Heimath geblieben bin.

CHEMISTRY.—XIII.

[*Continued from p.* 152.]

CHROMIUM—MANGANESE—TITANIUM—TIN—LEAD—COPPER.

We now come to a group of metals, Chromium, Molybdenum, Tungsten, and Uranium, each of which forms several compounds with oxygen. The highest of these oxides present well marked acid properties, forming stable salts with potassium, sodium, etc., thus being exceptions to the general rule that the oxides of metals are bases.

Chromium (Cr), atomic weight 52·1, specific gravity 7. This element is not very common; it occurs in nature as lead chromate, $PbCrO_4$, and as chrome iron ore, FeO,Cr_2O_3. The metal is obtained as an exceedingly hard infusible greenish powder by heating the oxide, Cr_2O_3, with carbon. It is not used for any purpose; it forms several oxides, CrO, Cr_2O_3, CrO_2, CrO_3. The highest oxide, CrO_3, forms an acid, and the lower oxides are bases. The sesquioxide, Cr_2O_3, is used as a green pigment, and for giving a green colour to glass; it can be prepared by heating ammonium bichromate, $(NH_4)_2Cr_2O_7$. It dissolves in acids, forming green or purple solutions. Important compounds of chromium are potassium chromate, K_2CrO_4, and potassium bi- or dichromate, $K_2Cr_2O_7$.

Potassium Dichromate ($K_2Cr_2O_7$) is made by heating chrome iron ore with potassium carbonate and lime with exposure to the air; the semi-fused yellow mass is extracted with hot water, and the quantity of sulphuric acid required by the equation—

$$2K_2CrO_4 + H_2SO_4 = K_2Cr_2O_7 + K_2SO_4 + H_2O,$$

added to convert the yellow chromate into the orange dichromate; the more insoluble dichromate crystallises out, as the solution cools, in orange-red crystals. The salt is used in dyeing, tanning, in photography, for one form of galvanic battery, etc.

When potassium dichromate is added to a solution of lead acetate, a yellow precipitate of lead chromate, $PbCrO_4$, is formed.

Solutions of salts derived from the oxide, Cr_2O_3, give a greenish precipitate with ammonium hydrate and ammonium chloride.

Manganese (Mn), atomic weight 55, specific gravity 7·5. This element occurs as the black oxide or pyrolusite, MnO_2, and as the carbonate, $MnCO_3$, which often forms beautiful rose-coloured masses. The metal is prepared by heating any of the oxides with charcoal to a very high temperature. It is a greyish metal which decomposes hot water; it is of no interest except in its alloys with iron—Spiegeleisen, ferro-manganese, etc., which are used in the Bessemer process for making steel. Manganese forms several oxides, MnO, Mn_3O_4, Mn_2O_3, MnO_2, MnO_3: the lower ones are bases, the highest forms an acid; and this seems to be a more or less general law. Most of the manganese salts are derived from the monoxide, MnO; the most common salt is manganous sulphate, it is obtained by mixing the black oxide with strong sulphuric acid, and then heating the mixture to redness; the ignited mass is extracted with water and the solution evaporated.

Black Oxide of Manganese (MnO_2) is called pyrolusite because it removes the green colour of common glass when fused with it (πῦρ, *pur*, fire, and λύω, *luo*, to wash). It is chiefly used for the manufacture of chlorine; it is found in nature in black compact masses. Neither the oxide, MnO_3, nor the acid, H_2MnO_4, have been prepared, but many of the salts, "manganates," of this acid are known: the most important are the manganates of potassium and sodium; they are obtained by fusing the black oxide with potassium or sodium hydrate with free exposure to the air—

$$2KHO + MnO_2 + O = K_2MnO_4 + H_2O.$$

The manganates form green solutions, which turn violet when diluted.

The oxide, Mn_2O_7, and the acid, $HMnO_4$, are only known in solution. Potassium permanganate, $KMnO_4$, can be prepared by passing carbon dioxide into a solution of potassium manganate until it is no longer alkaline; the solution is then evaporated, the green solution of the manganate is converted

into the purple permanganate, and yields dark purple crystals on evaporation.

Both manganates and permanganates are powerful oxidising agents, and so have been much used as disinfectants; the green Condy's fluid contains a manganate and the purple a permanganate.

A solution of a manganous salt gives no precipitate with ammonium chloride and ammonium hydrate, but a salmon-coloured precipitate with ammonium sulphide. All manganese compounds give a violet or amethyst-coloured borax bead, and when fused on platinum foil with potassium nitrate, yield a dark green mass of manganate.

Titanium and *Tin.* These two metals in some respects resemble the non-metallic element, silicon: they all form crystalline dioxides, SiO_2, TiO_2, SnO_2, and their tetrachlorides, $SiCl_4$, etc., are volatile fuming liquids which solidify on the addition of water.

Tin, Sn (*stannum*, the Latin name), atomic weight 118, specific gravity 7·3. This valuable metal occurs as the dioxide tinstone or cassiterite, SnO_2, in Cornwall, the island of Banca in the Malay Archipelago, Australia, etc. The ore is first broken up and washed to get rid of clay, etc., then roasted to drive off sulphur and arsenic, and finally mixed with about one-fifth of its weight of anthracite or Welsh coal; the mixture is heated, and the tin reduced to the metallic state, $SnO_2 + 2C = Sn + 2CO$. The tin thus obtained still contains arsenic and iron; it is again heated in a furnace with a sloping bed, the pure tin melts first and runs down the bed of the furnace, leaving the unmelted impurities behind. Tin is a bright white metal, it melts about 235°Cent., when bent it crackles, it is easily rolled out into foil, and is very malleable; it is soluble in strong hydrochloric acid; strong nitric acid converts it into a white powder which when dried yields the oxide, SnO_2, or "putty powder," used for polishing glass, etc. Tin is largely used for mixing with other metals, forming most valuable alloys: bell-metal (4 copper, 1 tin), gun-metal or bronze (9 copper, 1 tin), speculum metal, used for making mirrors for large telescopes (1 tin, 2 copper, and a little arsenic); with lead we have pewter (4 tin, 1 lead), soft solders (2 tin, 1 lead to 1 tin 2 lead); and Britannia metal (17 tin, 3 antimony, and a little zinc). An amalgam of tin and mercury is used for making looking-glass. Tin is also used for coating iron: the sheets of iron are carefully cleaned and then dipped into a bath of melted tin, the tin adheres and forms a brilliant coating. Sheet-iron coated with tin is often improperly called "tin," it should be called tin-plate.

Tin forms two series of compounds, the stannous salts derived from the oxide, SnO and the stannic salts from the oxide, SnO_2.

The most important stannous salt is *Stannous Chloride*, $SnCl_2$, made by dissolving tin in hydrochloric acid; it forms whitish crystals which dissolve in water, forming a more or less turbid solution; with gold chloride it gives a brown or purple precipitate, the "purple of Cassius," which is used for colouring glass purple.

Stannic Chloride ($SnCl_4$) is a fuming liquid obtained by distilling tin with corrosive sublimate; when about one-third of its weight of water is added, it solidifies into a crystalline mass, "butter of tin," or "oxymuriate of tin," $SnCl_4 + 5H_2O$; it forms a most valuable mordant for cochineal dyes. Tin forms two sulphides, *Stannous Sulphide*, which is a brown powder, or, when fused, a lead-grey mass; and *Stannic Sulphide*, SnS_2, which can be obtained of a beautiful golden colour, "Mosaic gold"—it is used as a bronze powder.

Solutions of stannous salts give with H_2S a brown precipitate of SnS, even in the presence of hydrochloric acid; they also give a white precipitate with mercuric chloride, which turns grey with excess of stannous salt. Stannic salts give a yellow precipitate with H_2S. Solid compounds of tin, when fused on charcoal with sodium carbonate and a little potassium cyanide, yield a white malleable globule of tin.

Lead, Pb (*plumbum*, Latin name), atomic weight 207, specific gravity 11·4, melts at 334° Cent. This metal has occasionally been found in nature in the metallic state; it also occurs as the carbonate, sulphate, chloride, etc., but its most important ore is the sulphide, PbS, galena, which occurs in Derbyshire, Laxey in the Isle of Man, Spain, America, etc—sometimes in glistening grey-black cubical crystals, sometimes in compact masses; it very often contains silver.

The ore is reduced either by fusing it with scrap iron, $PbS + Fe = Pb + FeS$, or by roasting it completely so as to convert it into an oxide, and then fusing with carbon, $PbO + C = Pb + CO$, or by carefully roasting the galena until two molecules of lead oxide are formed for every one molecule of galena left unoxidised; as soon as this stage of oxidation is reached, the heat is rapidly increased, so as to fuse the mixture, when the following reaction occurs, $PbS + 2PbO = SO_2 + 3Pb$.

Lead is a bluish white, malleable metal, and to a certain extent ductile. Lead, when freshly cut, has a bright surface, but this soon dulls when exposed to the air, but it does not oxidise to any depth; it is but little acted upon by dilute acids, with the exception of nitric acid, which dissolves it readily; lead is also soluble in hot strong hydrochloric and sulphuric acids. It is much used for covering roofs on account of its pliability, softness, and

darability, it is also easily melted. Raio or distilled water acts somewhat rapidly on lead in the presence of air; such water, when kept in leaden cisterns, etc., is poisonous; ordinary hard river and spring waters do oot act upoo lead (*see* Vol. IV., p. 65).

At the present time two processes of extracting small quantities of silver from large quantities of lead are in use, *Pattinson's* process and *Parkes's* process. The principle iavolved in Pettinson's process is that lead containing small quantities of silver is more fusible than pure lead. The lead containing tbo silver is melted and allowed to cool until it hegios to solidify, when a perforated iron ladle is dipped iato tbo semi-solid mass; the liquid metal which runs through is richer in silver thaa the solid portion which remains io tha ladle; by a systematio repetition of this process the lead is divided into two portions, ooa containiag but littlo silver (under 1oz. per ton), and o rich alloy containing 70 to 80 ounces per ton. Ia the Parkes process the silver lead is fused with about fivo per cent. of zinc, which dissolves out tha silver and rises to the top, forming when cold a cako of ziao which contains practically all the silver. Tho zino is easily distilled off by heat, and the silver remains.

Lead forms five oxides, three of which are important.

Lead Monoxide, lead ash, litharge, massicot (PbO). This occurs as a yellow or boff-coloured powder; it is produced when lead is heated in tbo air. When fused it forms a crystalline mass of litharge. It is used in tbo manafacture of flint glass, as a glaze for earthenware, for the preparation of red lead, etc.

Red Lead or *Minium* (Pb_3O_4) is a bright red powder obtained by carefolly heating litharge; it is much osed as a pigment. When heated with nitrio acid, it partly dissolves, forming lead nitrate, but a brown powder, PbO_2, remains behind undissolved.

Peroxide of Lead, brown or *puce-coloured oxide* (PbO_2). This is prepared by treating red lead with nitric acid as described above.

White Lead, $2PbCO_3 + Pb(HO)_2$, is a basio carbonate, *i.e.*, a carbonate containing hydrate. The hest white lead is made by a curious process called the "Dutch process." Small rolls of lead (Fig. 45) are placed in eartbenware jars containing a little vinegar, *i.e.* dilute acetio acid. The jars are arranged side by side, another row is placed over them, until a sort of stack of jars is formed, each jar containiag its roll of lead and vinegar. The whole is thoo covered with decaying stablo manore or spent tan: the decaying organio matter gives off heat and carbon dioxide. Under tho influence of the heat the acetic acid is converted into vapour and attacks the lead, forming a layer of acetate of lead; the carbonic acid from the manure converts the acetate into carbonate, and liberates the acetic acid, which eats still further into the lead. A second layer of acetate is formed, converted into carbonate, and so the process proceeds from tho outside to tho inside until tbo roll of lead is in the course of four to five weeks converted iato a mass of white lead. White lead is the basis of nearly all paints, it has the great disadvantage of turniog black whea exposed to the action of sulphur compounds.

Fig. 45.

Lead Chloride ($PbCl_2$) is obtained by dissolving lead in strong hydrochloric acid, or by adding hydrochloric acid to a strong solution of lead acetate, wheo the chlorido falls as a white precipitate. Lead chlorida is somewhat soluble in hot water: an oxychlorido of lead has been proposed as a sobstitoto for white lead in paints.

Lead Sulphate ($PbSO_4$) occurs native, and can be prepared by dissolving lead in strong sulphuric acid, by oxidising galena, PbS, or by adding dilute sulphuric acid to a solution of lead acetate; it is almost insoluble in water; it has also been suggested as a substitute for white lead.

Lead Acetate or *Sugar of Lead*, $Pb(C_2H_3O_2)_2$, sometimes abbreviated to $Pb\bar{A}_2$, is obtained by dissolving litharge in acetic acid; it occurs in commerce as a crystalline mass somewhat resembling loaf sugar, it has also a sweetish taste; it is much used as "driers" to promote the hardening of paint.

All soluble lead salts are poisonous—tho best antidote is aboot half an ounce of magnesium sulphate (Epsom salts) or sodium sulphate dissolved io plenty of warm water. Lead, evea wheo taken in small non-poisonous doses, accumulates in tha system until poisonous effects are produced. Workpeople who use lead compounds are thus subject to lead palsy, lead colic, etc. In most cases the lead is introduced from the clothes or the unwashed hands wheo taking food.

Solutions of lead salts give, if strong, a white precipitate with hydrochloric acid; this precipitate is not altered in appearance by the addition of ammonium hydrate, but dissolves in much boiling water. Hydrogen sulphide produces a black or brownish precipitate in lead solutions; dilute sulphuric acid gives a white precipitate of lead sulphate. Solid compounds containing lead when heated on charcoal with sodium carbonate give a malleable bead of metallic lead which is soft

enough to mark paper; round the bead will be seen a yellowish incrustation of lead oxide.

Copper, Cu (*cuprum*, Latin name), atomic weight 63·5, specific gravity 8·9, melts about 1,200° Cent. This metal has long been known; it occurs native, especially in the neighbourhood of Lake Superior; it is also found as the red oxide, Cu_2O, as the green "malachite," $CuCO_3 + Cu(HO)_2$, and the beautiful blue "azurite" or "chessylite," $2CuCO_3 + Cu(HO)_2$. The chief ores are, however, the sulphides, Cu_2S, CuS, and copper pyrites, $CuFeS_2$.

A large quantity of copper ore is smelted at Swansea; the ore may be roughly considered as a mixture of copper and iron sulphides with silica and other impurities. The process of obtaining metallic copper is rather complicated: the ore is first roasted and then fused, the iron oxide and silica form a slag of silicate of iron, while the copper is reconverted into sulphide, which melts and sinks to the bottom forming "coarse metal"; this still contains much iron, so the roasting and fusing are repeated with the coarse metal. Similar reactions occur, and the product is termed "fine metal," which is nearly pure copper sulphide. This is roasted until two molecules of copper oxide are formed for every one molecule of copper sulphide left unoxidised; the mixture is then fused, when the following reaction takes place — $2Cu_2O + Cu_2S = 6Cu + SO_2$ (compare Lead, p. 194). The product is blister copper, which is not tough and malleable enough for ordinary purposes, because, it is believed, it contains some copper oxide; it is, therefore, again fused and stirred with a pole of green wood, when much steam and gaseous hydrocarbons are evolved, which reduce the excess of oxide and convert the blister copper into "tough-pitch" copper.

Copper is also obtained by a "wet" process; the pyrites burnt in the manufacture of sulphuric acid (*see* Vol. IV., p. 259) usually contain about 3 per cent. of copper, so the residue obtained from the pyrites burners is heated with about 15 per cent. of common salt, and the copper chloride thus formed is extracted with water; scrap iron is then thrown in, and the copper deposited as a reddish powder.

Copper is our only red metal, it is very tough and malleable. It forms most valuable alloys: 2 parts of copper and 1 of zinc form brass; bronze or gun metal contains 9 of copper to 1 of tin, a trace of phosphorus is said to confer additional toughness and strength on bronze. Dutch metal used for imitation gold leaf contains 5 copper, 1 zinc, and a little tin. Copper is but little acted upon by the air; moisture and carbonic acid slowly convert it into the green carbonate—this is called "verdigris," a name also given sometimes to a basic acetate formed by the action of acetic acid or vinegar on copper. Copper is insoluble in dilute hydrochloric acid and in dilute sulphuric acid, but it is soluble in hot strong sulphuric acid, and dissolves readily in nitric acid.

Copper forms two principal oxides, cuprous oxide or suboxide, Cu_2O, and cupric or black oxide, CuO.

Cuprous Oxide (Cu_2O) is prepared by heating copper below a red heat, or by boiling a solution of copper sulphate with grape sugar and an excess of caustic potash, when the copper sulphate loses its blue colour, and the oxide falls as a red precipitate. This oxide colours glass a ruby-red.

Black Oxide of Copper (CuO) obtained as a black powder by heating copper in oxygen, or by heating the nitrate or carbonate. When heated with organic substances, as sugar, etc., it evolves oxygen, which burns up the organic matter, and so it is much used in organic analysis. It colours glass green.

Ordinary copper salts are mostly blue or green, the most important is the sulphate.

Cupric Sulphate or *Blue Vitriol* ($CuSO_4 + 5H_2O$) is prepared by roasting copper pyrites, $CuFeS_2$, carefully, when the copper sulphide is oxidised to copper sulphate, and the iron is converted into ferric oxide, Fe_2O_3. On extracting the roasted mass with water, the blue vitriol dissolves out, leaving the oxide of iron undissolved. The solution is evaporated, and the sulphate obtained in blue crystals. When heated to 240° the crystals crumble to a white powder, anhydrous copper sulphate, $CuSO_4$. Enormous quantities of copper sulphate are used for electrotyping.

Cupric salts are easily identified: their solutions are blue or green, they give with hydrochloric acid and hydrogen sulphide a black precipitate of cupric sulphide, CuS. When a very small quantity of ammonium hydrate is added to a cupric solution, a light blue precipitate is obtained. This instantly dissolves in an excess of ammonia to a beautiful deep blue solution. If a solution containing copper be acidulated with a drop of dilute sulphuric acid, and a bright steel knife blade, needle, etc., be placed in the solution, a red deposit of metallic copper will be formed in a few moments.

Copper salts give a green colour to the Bunsen flame (the chloride gives a blue flame edged with green) and a greenish blue borax bead in the outer blowpipe flame; in the inner blowpipe flame red opaque streaks are formed on the bead. If a solid copper salt be heated on charcoal with sodium carbonate, red scales of copper will be formed which, by careful management of the blow-

pipe flame, can be fused into a red metallic bead of copper.

All copper salts are poisonous; the best treatment is to administer an emetic of a tablespoonful of mustard in warm water, followed by copious draughts of milk, beaten-up white of egg, barley water, or gruel.

LATIN.—XXVIII.

[Continued from p. 195.]

LATIN VERSE.

YOU have now learned the principal rules by which the composition of Latin prose is controlled, and with some reading of authors, such as Cæsar and Cicero, you should be able to translate English into correct Latin. We shall now set before you the rules of Latin versification. If you continue your studies beyond the pages of the NEW POPULAR EDUCATOR, you will, no doubt, learn to compose Latin verses yourself; but this graceful accomplishment may not be acquired without infinite toil and patience. You can never hope to write half a dozen respectable lines of Latin verse unless you are born with an instinctive appreciation of words. And even if you are so fortunately endowed, you must cultivate your gift by the study of Vergil, Ovid, and the other classical poets. However, you will find it an easy task to gain some insight into the construction of hexameters, pentameters, and the rest; and as your understanding of poetry will be immensely quickened if you know where the cadence should fall, you are recommended to give your careful attention to the remarks which follow on scansion and versification.

Before we proceed to the discussion of the main question, we will clear the ground by giving you a few simple definitions. You have learnt that sound is produced by certain vibrations, and it is obvious that in pronouncing a word you may raise or lower the pitch of your voice in each syllable. This depression or elevation is known as *accent*. It is also possible to dwell upon a certain syllable, or hurriedly to pass over it. From this we get another definition, and say that *quantity* is the time during which we stay upon a syllable. All syllables are long or short, and as you have already learnt, a long syllable is distinguished by the mark —, a short syllable by the mark ˘. Thus, if you are writing out the following line, so as to display the sequence of long and short syllables, you mark it thus:

Armă vĭ- | rūmquĕ că- | nō, Trōj- | ǣ quī | prīmŭs ăb | ōrīs. ‖

In English, a high pitch coincides with a long syllable, so that accent and quantity are scarcely distinguishable. There is, however, a quantity to be marked on English vowels, but considerations of accent are paramount, and there are few poets who have written verses without violating the quantity of syllables. In English accent or stress overrides quantity, and we find the same syllables sometimes short, sometimes long. The famous soliloquy in *Hamlet* begins with the line—

Tŏ bē | ŏr nōt | tŏ bē | thāt ĭs | thĕ quēstion:
Whēthĕr | 'tis nōb- | lĕr ĭn | thĕ mīnd | tŏ sŭffer, etc.

In the first line you will notice that *is* is long; in the second it is short, while *to*, which is short in the first line, is seen to be long a little farther on:

Or tō | tăke ārms | ăgāinst | ă sēa | ŏf troubles.

In Latin verse, however, quantity is all important, and the principal rules which we shall now place before you are seldom violated. We shall frequently have to use the words *scan* and *scansion*; and before proceeding we must briefly define them for you. To *scan* a line is to break it up into the feet of which it is composed, while *scansion* is the process of thus separating the feet. Vertical lines are used to mark off the feet one from the other. *e.g.*—

Cœlūm | nōn ănĭ | mūm mū | tānt, quī | trāns mărĕ | cūrrŭnt. ‖

All syllables, then, are long or short, and in order to understand metre and versification, the first step is to learn to say at a moment's notice whether a syllable is long or short. So important have some teachers believed the knowledge of quantity, that to describe a short syllable as long (or to make a false quantity) has often been condemned as a moral delinquency. You must first note that a vowel may be long either by nature or by position.

I. The following vowels are long by nature:

(1) All vowels which result from the contraction of two other vowels are long: *e.g.*—

Cōgo (for coăgo), vēmens (for vĕhĕmens).

(2) Diphthongs (with few exceptions) are long: *e.g.*—

Quǣro, ǣqualis, sǣtus.

The following is the only exception which is of regular occurrence: the preposition *prae* in compound words is short when it is followed by a vowel: *e.g.*—

Prăeacutus, prăeire, etc.

II. (1) A vowel followed by two consonants, or a double consonant in the same word, is long, and here its quantity depends upon its position: *e.g.*—

Rēspondet, ābscondere.

When a word ends in a short vowel, and the word which follows it in a verse begins with *sc*, *sp*, *sq*, or *st*, it becomes long. But the arrangement which makes this lengthening possible is clumsy, and should be avoided.

(2) A short vowel, when followed by a mute and a liquid (*i.e.*, *br*, *tr*, *cr*, *tl*, *pl*, etc.), may be either short or long to suit the exigencies of the rhythm. Thus we may write *pătris* or *pātris*, *volŭcris* or *volūcris*.

(3) A vowel followed by another vowel, a diphthong or *h*, and a vowel, is short, so long as it does not coalesce with the syllable that follows it: *e.g.*—

Labōre, abĭit, vĕhementer, fŭisse.

To this rule there are a few exceptions. The *e* which precedes the *i* in the genitive and dative singular of nouns of the fifth declension is generally long. Thus we have *diēi* and *fidēi*, but the exception is not always observed, and *fidĕi* is frequently, and *spĕi* invariably found. The *i* in the genitives, *illius*, *ullius*, etc., is common—*i.e.*, it may be either long or short, according as the verse requires. A study of the poets will reveal to you a few more irregularities, but it is unnecessary to trouble you here with a detailed list.

To supplement these general rules, we must teach you how to determine the length of final syllables.

(1) Monosyllables are generally long: *e.g.*—

sī, nē, prō, vīs, tūs.

The following exceptions should be noted:—

(i.) Monosyllables which end in *b*, *d*, *l* (except *sāl* and *sōl*) and *t* are short: *e.g.*—

ăb, ĭd, vĕl, ĕt.

(ii.) Enclitics, *i.e.*, words which are attached to the end of other words and cannot stand alone, such as *quĕ*, *vĕ*, *nĕ* (asking a question), are short.

(iii.) A certain number of words which do not come under either of the above headings, such as *ĭn*, *pĕr*, *fĕr*, *vĭr*, etc.

2. (i.) In words of more than one syllable, final *a* is short if the word be not an ablative of the first declension, the imperative of the first conjugation, or an inalterable word such as *contrā*.

(ii.) Final *e* is short if the word be not an ablative of the fifth declension, the imperative of the second conjugation, or an adverb formed from an adjective, such as *fermē*.

(iii.) Final *i* is long, except in a few Greek words, and in *nisĭ* and *quasĭ*. In *mihi*, *tibi*, *sibi*, *ibi*, *ubi*, it may be either long or short.

(iv.) Final *o* is almost always long. In the first person singular of *scio* and *nescio*, it may be shortened, but it is only in the following words that it is commonly short, *citŏ*, *duŏ*, *egŏ*, *modŏ*, *octŏ*.

(v.) Final *u* is always long.

(vi.) Final *y* is always short.

(vii.) A vowel in a final syllable is short when it is followed by any one of the following consonants, *d*, *l*, *n*, *r*, and *t*: *e.g.*—

Illŭd, procŭl, culmĕn, calcăr, amăt.

(viii.) A vowel in a final syllable is long when followed by *c*: *e.g.*—

Illic, adhūc.

To this rule *donĕc* is the single exception.

(ix.) When the final syllable of a word ends in *s*, the following rules hold good:—

(*a*) Final *-as* is always long, except in *anăs*.

(*b*) Final *-es* is long, except in the nominative singular of nouns of the third declension, the penultimate syllable of whose genitive is short, as *hospĕs*, and in the preposition *penĕs*.

(*c*) Final *-is* is generally short, but it is long in the dative and ablative plural of nouns of the first and second declensions; in the second person singular of the present indicative of verbs of the fourth declension; in the second person singular of the present subjunctive of verbs and in some adverbs, such as *gratīs*.

(*d*) Final *-os* is long, except in *compŏs*.

(*e*) Final *-us* is usually short, but in the genitive singular and the nominative and accusative plural of nouns of the fourth declension it is long, as well as in the nominative singular of nouns of the third declension, whose genitive ends in *-ūtis*.

(*f*) Final *-ys* is short.

Attention to the above rules will enable the student to determine the quantity of most syllables, and an acquaintance with Vergil and Ovid should render the perpetration of false quantities impossible. But in order to appreciate Latin verse, something more than a knowledge of quantity is necessary. The mechanical part of versification consists in arranging words, so that long and short syllables follow each other in a certain order. When you analyse the construction of a line, you break it up into several combinations of syllables. These combinations are called *feet*. A metrical *foot* may consist of two, three, or even four syllables, and each foot has its technical name. The Romans learnt the art of versifying from the Greeks, and the names of all the feet are Greek, not Latin. We shall give a list of those which most frequently occur in Latin verse, and you must pick them out for yourself in the passages from Ovid and Vergil, which have been given you already.

A. Feet of two syllables:

1. Iambic, which consists of one short and one long: *ămānt*.
2. Spondee, which consists of two long: *dīcānt*.
3. Trochee, which consists of one long and one short: *ārmă*.
4. Pyrrhic, which consists of two short: *mĕŭ*.

The last foot is rarely met with in Latin verse.

B. The only feet of three syllables which are at all common in Latin verse are the dactyl, which consists of one long syllable and two short—*jūdĭcĕ*;

and the anapæst, which consists of two short syllables and one long—*mŏnĕāt*.

6. There are many feet of four syllables, but we shall only ask you to notice one, which is called the Choriambic, and is frequently employed by Horace, and is therefore of importance to the student of Latin. It consists of a long syllable, followed by two shorts and another long—*prāēmŏnĕānt*.

Feet, then, are the materials of verse, and they are combined in various orders to produce various metres.

THE METRES MOST COMMONLY EMPLOYED BY THE LATIN POETS.

1. *The Dactylic Hexameter.*—Heroic poems were generally written in dactylic hexameters, which consist of six feet, arranged as follows :—

— ⏑ ⏑ | — ⏑ ⏑ | — ⏑ ⏑ | — ⏑ ⏑ | — ⏑ ⏑ | — — ||
— — | — — | — — | — — | | — ⏑ ||

From this it will be clear to you that the last foot in the hexameter must be a spondee or trochee. The fifth foot is almost invariably a dactyl, as a spondee in that place gives the line an uncomfortable heaviness. The first four feet may be either dactyls or spondees. The rhythm and movement of the line depend upon the ingenuity with which dactyls and spondees are combined. It will be obvious to you, if you read half a dozen consecutive hexameters, that the more dactyls there are in a line, the more swiftly and easily it moves. But sometimes it is necessary to impart a solemnity and dignity to the verse, and this is attained by increasing the number of spondees. The strongest position in the line is the end, and here emphatic words are placed. There is one point of the utmost importance which must be noticed here. When the end of a word does not coincide with the end of the foot—that is, when a syllable is left over, this cutting off is termed a *cæsura*, and the syllable which is left over is called a *cæsural* syllable. *Cæsuræ* may occur in any part of the line, and give a strength and coherence to the verse. In hexameters, a cæsura is almost always found in the third foot, and without this break the line can never firmly hold together. If you mark off (or scan) the following lines for yourself, you will see how hexameters were built up by the greatest master who ever employed the measure :

> Jamque ascendebant collem, qui plurimus urbi
> Imminet adversasque aspectant desuper arces.
> Miratur molem Æneas, magalia quondam ;
> Miratur portas, strepitumque et strata viarum.

In the third line you will see that there is not a complete cæsura of the beginning of the third foot, and that the line suffers in consequence. But the harshness is toned down by the fact that the second foot does not end abruptly at the end of a word, as the *em* of *molem* is elided before the initial vowel of the next word.

THE PENTAMETER.

The name which has been given to this metre is somewhat confusing. According to the more convenient method of scanning it, it does not consist of five feet, but of two portions, each of which consists of two feet and a half. But some ancient grammarians dissected it after another method. They said it was made up of two dactyls or spondees, followed by a spondee and two anapæsts. Thus :

— ⏑ ⏑ | — ⏑ ⏑ | — — | ⏑ ⏑ — | ⏑ ⏑ — |
— — | — — |

Its construction seems simpler if we mark it off as follows : — ⏑ ⏑ | — ⏑ ⏑ | — ‖ — ⏑ ⏑ | — ⏑ ⏑ | ⏑ |
— — | — — | | | — |

There is here no principle involved. It is simply a matter of arrangement, and the latter method of scansion is more easily understood, and is therefore generally adopted.

The pentameter was never used by itself by classical writers, but always with hexameters, arranged alternately. When an hexameter was followed by a pentameter, the two lines were called an elegiac distich. If you look back to the earlier lessons, you will find some passages from Ovid which are in elegiac metre, and it will be a useful exercise for you to write them out and scan them.

In the construction of the pentameter the following points are to be noted :—The cæsura or break in the middle of the line always coincides with the end of a word, and elision is not permitted in this place. The last word in the pentameter may never be an adjective, unless the adjective has the force of a predicate, and in Ovid at least is nearly always a word of two syllables. To this last rule many exceptions occur, and words of one, three, four, and five syllables are found at the end of pentameters; but these exceptions are only permitted to give variety to the verse, and are but sparingly employed.

ALCAIC STANZA.

The large mass of Latin poetry is written either in hexameters or elegiacs—that is, in alternate hexameters and pentameters. There are, however, many other metres to be found in the works of the poets. Some of them are so rare as to be scarcely worth mention here, but others are handled with skill and elegance by Horace, and it is necessary for you to understand something of their construction. The most important of these measures is the Alcaic, so called because it was adopted by Horace from the Greek lyrical poet Alcæus. It is more

complicated than the measures which have already been explained to you, as it is a stanza of four lines, the third and fourth lines of which differ from the first two, and from one another. The following is the scheme of the Alcaic stanza:—

Lines 1 and 2. ⏓ ⏓ | ⏑ — | — ‖ — ⏑ ⏑ | — ⏑ ⏓ |.

Line 3. ⏓ ⏓ | ⏑ — | — — | ⏑ — | — ⏓ |.

Line 4. — ⏑ ⏑ | — ⏑ ⏑ | — ⏑ | ⏓ |.

If you scan the following stanzas, the first of which is from Horace, the second from Lord Tennyson, you will see how the Alcaic measure is built up:—

Odi profanum vulgus, et arceo;
Favete linguis carmina non prius
　Audita musarum sacerdos
　　Virginibus puerisque canto.

O mighty-mouthed inventor of harmonies,
O skill'd to sing of Time or Eternity,
　God-gifted organ-voice of England,
　　Milton a name to resound for ages.

In Horace there is always (with very few exceptions) a cæsura at the fifth syllable of the first and second lines. When this rule is violated, the cæsura generally falls upon a preposition compounded with a verb: *e.g.*—

Antehac | nefas | de ‖ promere Caecubum.

THE SAPPHIC STANZA.

The Sapphic stanza was copied by Horace from the works of the celebrated poetess Sappho. The following scheme is always observed by Horace:—

First 3 lines. — ⏑ | — — | — ⏑ ⏑ | — ⏑ | — ⏓ |

Fourth line. — ⏑ ⏑ | — — |

The following specimen from Horace will show you the structure of the Sapphic stanza:—

Lenit albescens animos capillus,
Litium et rixae cupidos protervae;
Non ego hoc ferrem calidus juventa
　Consule Planco.

In this stanza there is not a distinct break between the lines. A word may even be divided between the third and fourth lines, and between the second and third.

There are many other metres found in Horace and other poets, but they are infrequently used, and we must refer you to such books as Ramsay's *Manual of Latin Prosody* if you desire to continue your researches in this subject.

KEY TO EXERCISES.

(p. 133.)

Fingi haec putatis, judices, quae patent? Haec, quae nota sunt omnibus? quae tenentur? servorum exercitus illum in urbe conscripturum fuisse, per quos totam rempublicam, resque privatas omnium possideret? Quamobrem, si cruentum gladium tenens clamaret T. Annius: Adeste, quaeso, atque audite, cives: P. Clodium interfeci; ejus furores, quos nullis jam legibus, nullis judiciis frenare poteramus, hoc ferro et hac dextera a cervicibus vestris repuli, per me ut unum jus, aequitas, leges, libertas, pudor, pudicitia in civitate manerent; si res ita se haberent, esset vero timendum, quonam modo id ferret civitas! Nunc tamen quis est, qui non probet? qui non laudet? qui non unum post hominum memoriam T. Annium plurimum reipublicae profuisse, maxima laetitia populum Romanum, cunctam Italiam, nationes omnes affecisse et dicat et sentiat? Nequeo vetera illa populi Romani gaudia quanta fuerint judicare. Multas tamen jam summorum imperatorum clarissimas victorias aetas nostra vidit, quarum nulla neque tam diuturnam attulit laetitiam nec tantam.

(p. 134.)

Cicero Attico suo S.P.D.

Etsi nihil sane habebam novi, quod post accidisset, quam dedissem ad te Philogeni, liberto tuo, litteras, tamen quum Philotimum Romam remitterem, scribendum aliquid ad te fuit. Ac primum illud, quod me maxime angebat—non quo me aliquid juvare posses: res enim est in manibus, tu autem abes longe gentium. Obrepit dies, ut vides: mihi a. d. iii. Kal. Sextil. de provincia decedendum est. Quem relinquam, qui provinciae praesit? Ratio quidem et opinio hominum postulat fratrem. De illo autem primum illud est: persuaderi ei non posse arbitror; odit enim provinciam, et hercule nihil odiosius, nihil molestius . . . . Magna igitur, ut vides, sollicitudine afficior, magna inopia consilii. Quid quaeris? toto negotio nobis opus non fuit . . . Omnino—soli enim sumus—nullas unquam ad me litteras misit Brutus, in quibus non inesset arrogans aliquid: in quo tamen ille mihi risum magis quam stomachum movere solet; sed plane parum cogitat, quid scribat aut ad quem. Q Cicero puer legit epistolam inscriptam patri suo—solet enim aperire, idque de meo consilio, si quid forte sit quod opus sit sciri; in ea autem epistola erat illud idem de sorore, quod ad me: mirifice conturbatum vidi puerum; lacrimans mecum est questus: quid quaeris? miram in eo pietatem suavitatem humanitatemque perspexi. Id te igitur scire volui . . . . Etiam illud: orationem Q. Celeris mihi velim mittas contra M. Servilium. Litteras mitte quam primum; vel per tuum tabellarium. Mulierem egregiam et filiam saluta nostris verbis. Cura ut valeas. Multum te amamus. Vale. Dat. a Cilicia a. d. v. Kal. Quinct.

Balbus Q. Hirtio S.

Accepi a te aliquot epistolas uno tempore, quas tu diversis temporibus dederas. Sic habeto, non tibi majori esse curae id negotium, quam mihi . . . . Sed, ut ad epistolas tuas redeam, caetera belle, unum tamen miror. Quis, excepto te, plures eodem exemplo dare solet, qui sua manu scribit? Nam quod in palimpsesto, laudo equidem parcimoniam. Sed miror quid in illa chartula fuerit, quod delere malueris quam haec non scribere, nisi forte tuas orationes. An hoc significas, nihil fieri, frigere te, ne chartam quidem tibi suppeditare? Jam ista tua culpa est, qui verecundiam tecum extuleris et non hic nobiscum reliqueris. Tu, si intervallum longius erit mearum litterarum, ne sis admiratus: eram enim abfuturus mense Maio. Cura ut valeas. Bruto salutem dic. A Tulliola sal vebis. vi. Idus April. Brundisio.

Epistolam tuam, quam accepi ab L. Arruntio, conscidi innocentem: nihil enim habebat quod non vel quovis recte legi posset. Sed et Arruntius ita te mandasse aiebat et tu ascripseras. Verum illud esto. Nihil te ad me postea scripsisse demiror, praesertim tam novis rebus.

HISTORIC SKETCHES, GENERAL.—VIII.

[Continued from p. [illegible].]

THE SPANIARDS IN AMERICA.

"AND there being among the Spaniards some who are not only cruel, but very cruel, when a man occasionally wishes to punish a slave, either for some crime that he had committed, or for not having done a good day's work, or for spite that he had towards him, or for not having extracted the usual quantity of silver or gold from the mine, when he came home at night, instead of giving him supper, he made him undress, if he happened to have a shirt on, and being thrown down upon the ground, he had his hands and feet tied to a piece of wood laid across, so permitted under the rule called by the Spaniards the law of Baiona—a law suggested, I think, by some great demon; then with a thong or rope he was beaten, until his body streamed with blood; which done, they took a pound of pitch or a pipkin of boiling oil, and threw it gradually all over the unfortunate victim; then he was washed with some of the country pepper mixed with salt and water. He was then left on a plank covered over with a cloth, until the master thought he was able again to work. Others dug a hole in the ground and put the man in, upright, leaving only his head out, and left him in all night; the Spanish saying that they have recourse to this cure because the earth absorbs the blood and preserves the flesh from forming any wound, so they get well sooner. *And if any die (which sometimes happens) through great pain, there is no heavier punishment by law than that the master shall pay another slave to the king.*"

MEETING BETWEEN PIZARRO AND ATAHUALPA.

Thus wrote Girolamo Benzoni the Milanese, who, in the year 1541, "started from Milan in the name of God, the sustainer and governor of all the universe," to seek his fortune or whatever might present itself to him in the newly discovered possessions of the Spaniards across the Atlantic. Benzoni was, to judge from his own account of his travels, a perfectly ingenuous man, who mentioned gravely and without aiming at effect whatever came under his notice, nothing extenuating nor setting down aught in malice. He was not particularly squeamish about what he did or what others did, though he appears to have had what was lacking in the Spanish composition—some of the feelings of the human heart. He is, therefore, a very fair unprejudiced witness in respect of the Spanish treatment of the Indians, and his testimony is, moreover, abundantly confirmed by that of many others equally disinterested.

It is a sad and singular history, that of the conquest and possession of the West Indies and America by the Spaniards. However, it is proposed here simply to give a slight sketch of the Spanish doings in America and the Indies after obtaining possession of them, how they furiously raged

together, imagined all sorts of vain things, and how in the end the power was reft from them.

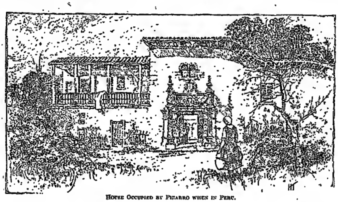
The first permanent settlement made in the West was on Haiti, or, as Columbus called it, La Isla Española, of which Bartholomew Columbus was made governor on his brother Christopher's return to Spain. During his administration all went well with the colony, the Indians wondering at the bearded men who had come they knew not whence with iron tubes from which they hurled lightnings, and by the aid of which they made noises like thunder; but discord sprang up before Christopher's return, the Spaniards ill-used the women, beat the men, and otherwise behaved oppressively; and the Indians having ascertained, by the purely philosophical process of holding a Spaniard under water for ten minutes, that the new-comers were mortal, rose against them when familiarity had somewhat taken away the dread of them, and killed some of the garrison.

So long as Columbus and his brother remained in authority the Indians had tolerable treatment, for the influence of the two, weakened though it was by jealousies and mutinies, which sprang up among the Spaniards, was strong enough to hold the greater part of the adventurers in check; but when Spanish governors came to be in power, and every consideration was sacrificed to the greed for gold, the most merciless demands for life were made in order to supply the slave labour necessary for the working of the mines. So rapid was the loss of life from this cause—for the Indians had never been accustomed to such severe work—that in a few years Haiti was all but depopulated, and the Spaniards brought in slaves from the neighbouring islands and from the mainland to fill their place. Puerto Rico, Cuba, Jamaica, and all the lesser islands were brought under the yoke; Jamaica, which was densely populated, but which did not yield gold, being made the slave-mart for the gold-seekers, who caught the people as they would have snared so many wild beasts, and shipped them off to the islands where the mines were. Haiti remained for many years the headquarters of the Spanish Government in the West Indies, but when the attractions of the mainland of Mexico, Peru, and Chili had drawn away many Spaniards, and the negroes imported from Africa began to be more numerous than consorted with the safety of the whites, the island was virtually abandoned, and each separate governor of an island or a province received his orders direct from Spain.

The Spaniards having spoiled all the islands of the West Indies—those which yielded gold for sake of the gold, and those which yielded only slaves for sake of the slaves—turned their attention to the mainland, which hitherto they had not thoroughly explored. Balboa, an independent pioneer, made a settlement on the Isthmus of Darien, and having there learnt that on the other side of the isthmus was a kingdom in which any quantity of gold was to be had for the seeking, sent to Isla Española for reinforcements, and went meantime himself with a small body of men to where the mighty Pacific was first revealed to the eyes of a European. Gathering as much gold as he could get, and which the native chiefs freely gave him, he returned for assistance, not daring with his few friends to draw down the hostility of the wealthy nation which he understood was also exceedingly strong. On April 2nd, 1519, an extensive expedition, which had been fitted out in the ports of Cuba, and which sailed under the command of Fernando Cortez, landed on the coast of Yucatan, and was well received by the natives. Cortez immediately formed an entrenched camp, which subsequently became the city of Vera Cruz, and having established himself there, began to negotiate for an interview with Montezuma, the emperor of the country.

Whether the Mexicans suspected the character of the wolves who came to them in sheep's clothing; whether the Spaniards, as is most likely, did not refrain from acts of violence even at the beginning of their occupation; or whether it was from fear of the firearms which so greatly astonished the people, the Mexicans held back from this proposal. Montezuma sent rich presents which only inflamed the greed of the Spaniards, and Cortez, after entering into alliances with tribes discontented with the government, marched inland with 500 foot soldiers, fifteen horsemen, and six pieces of cannon. With such a force he proposed to himself the conquest of a populous and powerful empire. By striking terror into opponents who had never seen a gun fired until now, by artifice, by playing off hostile chiefs one against the other, Cortez marched on, his admiration being excited at every step by the magnificence of the scenery, and his cupidity aroused by the signs which he daily saw of the enormous wealth of the soil. After short sojourns in some of the cities, which fell before him like snow before the sun, he advanced to the city of Mexico, in the environs of which Montezuma came out to meet him in friendly sort, with barbaric but splendid state, and magnificent gifts. The emperor was so gracious and hospitable that Cortez had much difficulty in knowing how even he was to begin playing the villain. The Spaniards were brought into the city, lodged, fed, and clothed, and all that they wanted was supplied to them. Cortez resolved to avail himself of an outrage on some Spaniards on the coast to possess himself of

the person of Montezuma. He first complained of the outrage and demanded the punishment of the murderers, who, including a cacique or chief, were brought to Mexico and burned alive as a punishment; but the sufferers having averred, truly or not,



HOUSE OCCUPIED BY PIZARRO WHEN IN PERU.

that what they had done was by Montezuma's own order, Cortez seized the emperor, and kept him a prisoner in irons in the Spanish quarters. He wrote to the King of Spain, telling him what he had done, and how he had done it for the better security of the lives of the Spaniards in Mexico, and for the purpose of more effectually bringing the empire under the dominion of the Spanish king. The enormous consignments of gold sent to Europe astonished the Old World folk, and attracted thousands of them across the water. The gold itself was spent in attempts to found universal dominion, and in endeavours, continued through many years, to crush out as a plague the spirit of liberty both in church and state. In Mexico, after the imprisonment of Montezuma, the Mexicans were compelled to be the slaves of the Spaniards and to work their own gold mines for them. The waste of life became as prodigious as in the West India Islands, and the sufferings of the people so great that the Spanish priests remonstrated, and orders were obtained from the Pope and from the King of Spain for the better treatment of the Indians. But such orders to a man like Cortez were as nothing, and the state of the poor people grew worse and worse. They had resolved at any cost to get rid of their tyrants, when Cortez was called away from the capital to fight a Spanish expedition which had been sent from Cuba, the governor of which thought fit to override the authority of Cortez, and to seek himself to gather where he had not sown. Cortez defeated the expedition, killed its leader, and induced the soldiers to enlist under him.

On his return to Mexico city his quarters were assailed by a vast multitude of Mexicans, desperate at the return of their dreadful enemy, and bent on his destruction. In vain did Cortez try everything that skill or valour could dictate, in vain did he bring out Montezuma on the ramparts to quiet the people. Montezuma was killed by a missile flung by one of his own subjects, and Cortez and his followers had to cut their way out of the city. In due time he returned with fresh troops procured from Isla Española, and captured the city; the successor of Montezuma was put to death by slow torture, multitudes of Mexicans were slain, and possession was formally taken of the country as a dependency of Spain.

Twelve years after Cortez had landed at Vera Cruz, Pizarro (in 1531) arrived with a small force on the coast of Peru, and dissembling his object from the people who probably did not know what had befallen Mexico, advanced inland, pretending that he would mediate between Huascar and Atahualpa, sons of the late Inca or king, who were striving for the mastery. Atahualpa had the upper hand, and Pizarro managed to get his consent

to an interview, at which the intention was to sieze the Inca, and hold him as a hostage and as a lever of power. At the meeting the Inca was informed that Alexander VI., Pope of Rome, had given Peru and all the other kingdoms in America to the Spaniards; that the Pope of Rome was lord of the whole earth by virtue of his being vicegerent of Christ, of whom until this moment the Inca had never heard. Atahualpa was required to acknowledge the supremacy of the King of Spain, and to be baptised into the Christian faith. On the luckless man treating these modest demands with derision, a tumult was raised, a heavy fire of musketry and artillery was opened on the Peruvians, and Atahualpa was seized and loaded with irons. Cruel as had been the conduct of the Spaniards in Mexico, it was *very* cruel in Peru; the greatest frauds were practised on the natives, who were reduced to the most dreadful form of slavery, and compelled to yield forced labour. Atahualpa was made to pay as ransom a room full of bars of gold, and then, the gold having been received, he was strangled, and his body burned at a stake. Furious dissensions arose among the Spaniards about the division of the spoil; Pizarro was murdered, his murderer succumbing in turn to some other ruffian, and a long period of anarchy and bloody revolution ensued, during which the native Peruvians suffered from each successive ruler.

Besides the West Indies, Mexico, Peru, and Chili, the Spaniards did not care for their other possessions in America, which fell in course of time under the dominion of the English, French, and Dutch, and include at the present day the whole of the United States of America.

What of all they once held do the Spaniards retain at this moment? Absolutely nothing at all! Ruthless, selfish government like that they set up, practices subversive of all good such as they practised, could bring about but one conclusion. Even in Benzoni's time (1550), the demoralisation was such that "many Spaniards prophesied for certain that the island (Isla Española) in a short time will fall entirely into the hands of these blacks" (imported Africans), and such has been its fate, after many and deadly struggles between Spaniards, French, and English for the mastery there. When the news of the French Revolution in 1789 reached the island, the French being then masters, the population rose *en masse*, and in the awful massacre of San Domingo repaid the wrongs of centuries. Jamaica was taken from Spain by commanders sent by Cromwell, and since that time successive conquests have stripped her of all; Cuba and Puerto Rico, the sole remaining relics of their once vast American possessions, being the last to go.

Mexico, Peru, and Chili remained under the curse of Spanish rule till quite recent times; but the bursting of the old bands of tyranny in Europe by Napoleon Bonaparte loosened them indirectly in America. As soon as it was known in Mexico (in 1808) that the Spanish Bourbons were overthrown, the viceroy called on the people to support King Ferdinand, but when they rose to do so, the Spanish colonists resented their interference, though it was on their own behalf. "No native American shall participate in the government so long as there is a mule-driver in La Mancha, or a cobbler in Castile, to represent Spanish ascendency." In this spirit the Spaniards in Mexico conducted themselves, and the result was that after three formidable insurrections, bloodily suppressed, Iturbide, a native Mexican, so gathered up the national party into his hands that he drove the Spaniards out, and received on the 27th of November, 1821, the surrender of the capital on condition that the Spaniards should forthwith leave the country.

After passing through a dreadful ordeal analogous to the above, Peru and Chili, making common cause, threw off the Spanish yoke, and on the 26th of February, 1826, compelled the surrender of Callao, the last foothold of the Spaniards on the territories won for them by Cortez and Pizarro.

See:—Cassell's Universal History.

GREEK.—IV.

[*Continued from p.* 143.]

THE SECOND DECLENSION.

THERE are in the Greek second declension two terminations—that in *-ος* corresponding to the Latin *-us*, and that in *-ον* corresponding to the Latin *-um*. Of the nouns which terminate in *-ος* the greater number are of the masculine gender, some are also feminine; nouns in *-ον* are of the neuter gender, except "diminutive" female names, as ἡ Γλυκέριον, *Glycerium*.

The following table presents

THE CASE-ENDINGS OF THE SECOND DECLENSION.

	Singular.	*Plural.*	*Dual.*
Nom.	-ος, -ον	-οι, -ᾰ	-ω
Gen.	-ου	-ων	-οιν
Dat.	-ῳ	-οις	-οιν
Acc.	-ον	-ους, -ᾰ	-ω
Voc.	-ε (-ος), -ον	-οι, -ᾰ	-ω

Before passing on, let the learner turn back and compare these terminations with those that are given in connection with the article; then he will readily commit these to memory:—

PARADIGMS OR EXAMPLES OF THE SECOND DECLENSION.

	Word.	Island.	God.	Messenger.	Fig.
	Singular.				
Nom.	λόγος, m.	νῆσος, f.	Θεός, m.	ἄγγελος, m.	σῦκον, n.
Gen.	λόγου.	νήσου.	Θεοῦ.	ἀγγέλου.	σύκου.
Dat.	λόγῳ.	νήσῳ.	Θεῷ.	ἀγγέλῳ.	σύκῳ.
Acc.	λόγον.	νῆσον.	Θεόν.	ἄγγελον.	σῦκον.
Voc.	λόγε.	νῆσε.	Θεός.	ἄγγελε.	σῦκον.
	Plural.				
Nom.	λόγοι.	νῆσοι.	Θεοί.	ἄγγελοι.	σῦκα.
Gen.	λόγων.	νήσων.	Θεῶν.	ἀγγέλων.	σύκων.
Dat.	λόγοις.	νήσοις.	Θεοῖς.	ἀγγέλοις.	σύκοις.
Acc.	λόγους.	νήσους.	Θεούς.	ἀγγέλους.	σῦκα.
Voc.	λόγοι.	νῆσοι.	Θεοί.	ἄγγελοι.	σῦκα.
	Dual.				
N.A.V.	λόγω.	νήσω.	Θεώ.	ἀγγέλω.	σύκω.
G.D.	λόγοιν.	νήσοιν.	Θεοῖν.	ἀγγέλοιν.	σικοιν.

The vocative of the words in *-ος* commonly ends in *-ε*, but often—especially in adjectives and participles—the nominative in *-ος* is used for the vocative in *-ε*; as ὦ φίλε, also ὦ φίλος; but θεός, like the Latin *Deus*, has always θεός as vocative.

Like Latin nouns in *-um*, the Greek neuters in *-ον* have the same ending in the nominative, accusative, and vocative—namely, *-ον* in the singular, and *-α* in the plural.

The models just given are followed by adjectives in *-ος* (m.), *-ον* (n.): as, ἀγαθός (ἀγαθή, f., like the first declension), ἀγαθόν; as appears in the following

MODELS OF ADJECTIVES AND NOUNS OF THE SECOND DECLENSION.

	A Good Word.	A Good Child
	Singular.	
Nom.	ἀγαθὸς λόγος.	ἀγαθὸν τέκνον
Gen.	ἀγαθοῦ λόγου.	ἀγαθοῦ τέκνου
Dat.	ἀγαθῷ λόγῳ.	ἀγαθῷ τέκνῳ.
Acc.	ἀγαθὸν λόγον.	ἀγαθὸν τέκνον
Voc.	ἀγαθὲ λόγε.	ἀγαθὸν τέκνον
	Plural.	
Nom.	ἀγαθοὶ λόγοι.	ἀγαθὰ τέκνα.
Gen.	ἀγαθῶν λόγων.	ἀγαθῶν τέκνων.
Dat.	ἀγαθοῖς λόγοις.	ἀγαθοῖς τέκνοις
Acc.	ἀγαθοὺς λόγους.	ἀγαθὰ τέκνα.
Voc.	ἀγαθοὶ λόγοι.	ἀγαθὰ τέκνα.
	Dual.	
N.A.V.	ἀγαθὼ λόγω.	ἀγαθὼ τέκνω.
G.D.	ἀγαθοῖν λόγοιν.	ἀγαθοῖν τέκνοιν.

The foregoing relates to adjectives of three terminations. Adjectives of two terminations are also declined in the same manner—namely, such as end in *-ος* (m. and f.) and *-ον* (n.), as παγκαλός, παγκαλόν, entirely beautiful: for example, ἡ παγκαλὸς οἰκία, the entirely beautiful house; τὸ παγκαλὸν τέκνον, the entirely beautiful child.

N.B.—It may be noted that *Compound* or *Derivative* adjectives are generally of two terminations.

For the sake of practice, we here subjoin an example of an adjective of three terminations, and one of two terminations, advising you to learn them horizontally as well as perpendicularly.

ADJECTIVES OF THREE AND TWO TERMINATIONS, LIKE THE FIRST AND SECOND DECLENSIONS.

	Wise.	Orderly.
	Singular.	
Nom.	σοφός, -ή, -όν.	κόσμιος, -ον.
Gen.	σοφοῦ, -ῆς, -οῦ.	κοσμίου, -ου.
Dat.	σοφῷ, -ῇ, -ῷ.	κοσμίῳ, -ῳ.
Acc.	σοφόν, -ήν, -όν.	κόσμιον, -ον.
Voc.	σοφέ, -ή, -όν.	κόσμιε, -ον.
	Plural.	
Nom.	σοφοί, -αί, -ά.	κόσμιοι, -α.
Gen.	σοφῶν, -ῶν, -ῶν.	κοσμίων, -ων.
Dat.	σοφοῖς, -αῖς, -οῖς.	κοσμίοις, -οις.
Acc.	σοφούς, -άς, -ά.	κοσμίους, -α.
Voc.	σοφοί, -αί, -ά.	κόσμιοι, -α.
	Dual.	
N.A.V.	σοφώ, -ά, -ώ.	κοσμίω, -ω.
G.D.	σοφοῖν, -αῖν, -οῖν.	κοσμίοιν, -οιν.

Before you attempt the following exercises, you must understand that Greek nouns in the neuter plural require their verb to be in the singular number: *e.g.*, Τὰ τέκνα ἀγαθά ἐστι, the children are good.

VOCABULARY.

Ἀγαθός, -ή, -όν, good.
Ἀδελφος, -ου, ὁ, a brother.
Ἀλλά (ἀλλ'), but.
Ανθρωπος, -ου, ὁ, a man.
Διδάσκαλος, -ου, ὁ, a teacher.
Δοῦλος, -ου, ὁ, a slave.
Ἔργον, -ου, τό, a work.
Ἐσθλός, -ή, -όν, excellent.
Ἐχθρός, -ά, -όν, hostile, hateful; ὁ ἐχθρός, the enemy.
Ἑταῖρος, -ου, ὁ, a companion, friend.
Θεός, ὁ, God, the true God.
Κακός, -ή, -όν, bad; τὰ κακά (Latin, *mala*), evils.
Καλός, -ή, -όν, fair, beautiful.
Κίνδυνος, -ου, ὁ, danger.
Μετέχω (with gen.), I partake, share.
Μίσγω (Latin, *misceo*; English, *mix*), I mix (acc. and dat.).
Οἶνος, -ου, ὁ, wine.
Παρέχω, I give, bestow.
Πιστός, -ή, -όν, faithful.
Πολλοί, -αί, -ά, many, numerous.
Φίλος, -η, -ον, loving, friendly.
Φροντίζω (gen.), I care for.
Χαίρω (dat.), I rejoice at.
Χαλεπός, -ή, -όν, hard, difficult.

EXERCISE 11.

Translate into English:—

1. Δίωκε καλὰ ἔργα, ὦ φίλε νεανία. 2. Πείθου τοῖς τοῦ διδασκάλου λόγοις. 3. Παρ' ἐσθλῶν ἐσθλὰ μανθάνεις. 4. Πιστὸς ἑταῖρος τῶν ἀγαθῶν καὶ τῶν κακῶν μετέχει. 5. Οἱ Θεοὶ τῶν ἀνθρώπων φροντίζουσιν. 6. Οἱ ἄνθρωποι τοὺς Θεοὺς θεραπεύουσιν. 7. Πολλοῖς ἔργοις ἕπεται κίνδυνος. 8. Μίσγεται ἐσθλὰ κακοῖς. 9. Ὁ κακὸς τοῖς θεοῖς καὶ τοῖς ἀνθρώποις ἐχθρός ἐστιν. 10. Οἱ ἄνθρωποι τοῖς ἐσθλοῖς χαίρουσιν. 11. Πάρεχε, ὦ Θεός, τοῖς φίλοις εὐτυχίαν. 12. Φέρε, ὦ δοῦλε, τὸν οἶνον τῷ νεανίᾳ. 13. Ὁ οἶνος οὐ λύει ἀλλὰ τίκτει τὰς μερίμνας. 14. Χαλεπῷ ἔργῳ δόξα ἕπεται.

EXERCISE 12.

Translate into Greek:—

1. Good men obey God. 2. Bad men obey not God. 3. O good youths, obey your (the) teacher. 4. Bad men are hostile to the good (*the bad—the good*). 5. Abstain from bad men. 6. Good men take care of their (the) children. 7. Trust not the word of a liar, O dear boy. 8. Dangers follow many words. 9. Good youths honour their (the) teachers.

Remarks.—The Greeks are fond of such an arrangement of words as is found in the phrase, τοῖς τοῦ διδασκάλου λόγοις, given above. Literally, and in the Greek order, the words run—*the of the teacher words*; that is, *the words of the teacher*. Imitate this construction. In general, the Greek order of words approaches more nearly to the English than does the Latin. The sense, however, logically considered, prevails over other considerations in the Greek collocation of words. The chief place of emphasis is the commencement of a sentence, the next is the end. Not by any mere rule, however, can the beginner acquire the tact of placing the Greek words in their idiomatic order. From attention to the sentences given in the exercises, and by making them, as far as possible, models, he may learn much and make an approach to correctness; but, after all, nothing but a long and careful study of the writings of the classics themselves can give him complete skill. The student, however, is specially requested to note what is called the *emphatic* collocation of the adjective with its noun, where the adjective and noun have each an article, in the following order—article, noun, article, adjective, as in τὸ φῶς τὸ ἀληθινόν, the light, the true light (John i. 9). With this, we may compare in English, especially in poetry, the repetition of a noun with the adjective for the sake of *emphasis*, as in Shakespeare: "Farewell, a long farewell"; "A frost, a killing frost."

VOCABULARY.

Ἄξιος, -α, -ον (gen.), worthy.
Ἀπολύω (gen. of the thing), I free from.
Ἄργυρος, -ου, ὁ, silver.
Βίος, -ου, ὁ, life.
Βουλή, -ῆς, ἡ, counsel.
Διχοστασία, -ας, ἡ, division.
Εὐφραίνω, I make joyful.
Θάνατος, -ου, ὁ, death.
Θεῖος, -α, -ον, divine; τὸ Θεῖον, the Divinity.
Θύμος, -ου, ὁ, mind, courage, spirit.
Θύρα, -ας, ἡ, a door.
Κλείω, I shut.
Μέτρον, -ου, τό, a measure.
Μοχλός, -οῦ, ὁ, a bolt.
Μύριος, -α, -ον, innumerable.
Νέος, -α, -ον, young; ὁ νέος, a young man.
Νόσος, -ου, ἡ, sickness.
Οὐχ (οὐχ comes before an aspirated vowel, instead of οὐκ and οὐ), not.
Πόνος, -ου, ὁ, labour.
Σιγή, -ῆς, ἡ, silence.
Χρόνος, -ου, ὁ, time.
Χρῦσος, -ου, ὁ, gold.

EXERCISE 13.

Translate into English:—

1. Τὸ καλόν ἐστι μέτρον τοῦ βίου, οὐχ ὁ χρόνος. 2. Ὁ θάνατος τοὺς ἀνθρώπους ἀπολύει πόνων καὶ κακῶν. 3. Ὁ οἶνος εὐφραίνει τοὺς τῶν ἀνθρώπων θύμους. 4. Σὺν μυρίοις πόνοις τὰ καλὰ γίγνεται. 5. Τὸ θεῖον τοὺς κακοὺς ἄγει πρὸς τὴν δίκην. 6. Πιστὸς φίλος χρύσου καὶ ἀργύρου ἄξιός ἐστιν ἐν χαλεπῇ διχοστασίᾳ. 7. Πολλαὶ νόσοι ἐν ἀνθρώποις εἰσίν. 8. Βουλὴ εἰς ἀγαθὸν ἄγει. 9. Σιγὴ νέῳ τιμὴν φέρει. 10. Ἡ θύρα μοχλοῖς κλείεται. 11. Ἡ τέχνη τοὺς ἀνθρώπους τρέφει. 12. Ὦ φίλοι μαθηταί, τῆς σοφίας καὶ τῆς ἀρετῆς ὀρέγεσθε.

EXERCISE 14.

Translate into Greek:—

1. By death (dat.) men are set free from labours. 2. Many labours attend on life. 3. The wisdom of the Divinity leads good men to happiness. 4. Follow the words of the judge. 5. The words of the youth are bad. 6. The lyre dissipates (λύω) the cares of the mind. 7. Silence becomes a boy. 8. Art nourishes good men. 9. The bolt shuts the door.

A few masculine and feminine nouns and adjectives have the termination -ως (with -ων as neuter in adjectives), the -ω being retained through all the cases. Though this form occurs in Ionic writers, as Herodotus, yet it bears the name of

THE ATTIC DECLENSION.

Singular.

	The people.	*The threshing floor.*	*Merciful.*	
Nom.	ὁ λεώς.	ἡ ἅλως.	ὁ, ἡ ἵλεως,*	τὸ ἵλεων.
Gen.	λεώ.	ἅλω.	ἵλεω.	
Dat.	λεῴ.*	ἅλῳ.	ἵλεῳ.	
Acc.	λεών.	ἅλων.	ἵλεων.	
Voc.	λεώς.	ἅλως.	ἵλεως.	ἵλεων.

* It will be noticed that the accentuation of this declension is irregular. The genitive and dative when accented on the last syllable are oxytone, and εω passes as one syllable.

		Plural.		
Nom.	λεῴ.	ἅλῳ.	οἱ, αἱ, ἵλεῳ.	τὰ ἵλεα.
Gen.	λεών.	ἅλων.	ἵλεων.	
Dat.	λεῴς.	ἅλῳς.	ἵλεῳς.	
Acc.	λεώς.	ἅλως.	ἵλεως.	ἵλεα.
Voc.	λεῴ.	ἅλῳ.	ἵλεῳ.	ἵλεα.
		Dual.		
N.A.V.	λεώ.	ἅλω.	ἵλεω.	
G.D.	λεῴν.	ἅλῳν.	ἵλεῳν.	

Additional examples are given in the vocabulary below. Of these, all but λεώς may have the accusative in -ω (the ν being dropped), and ἕως always has.

VOCABULARY.

Ἀγήρως, -ων, free from old age, deathless (α, not; γῆρας, old age).
Ἀετός, -οῦ, ὁ, an eagle.
Αἰχμάλωτος, -ου, ὁ, a prisoner.
Ἀνδρεῖος, -α, -ον, manly, brave.
Ἀνδρόγεως, -ω, ὁ, Androgeus (a proper name).
Ἀπάγω, I lead away.
Βαίνω, I walk, go.
Ἐνεδρεύω, I lie in wait, capture.
Ἔπαινος, -ου, ὁ, praise.
Εὔχομαι, I pray (with dat.).
Ἕως, -ω, ἡ, dawn.
Ἥρα, -ας, ἡ, Hera (called by the Latins, Juno).
Θηρεύω, I hunt, catch.
Θηρευτής, -οῦ, ὁ, a huntsman.
Κάλως, -ω, ὁ, a rope.
Κτίζω, I found, build.
Λαμβάνω, I take.
Λαγώς, -ώ, ὁ, a hare.
Μενέλεως, -ω, ὁ, Menelaus (a proper name).
Μίνως, -ω, ὁ, Minos (a proper name).
Νεώς, -ώ, ὁ, a temple.
Πλεῖστος, -η, -ον, most, very many.
Πτέρον, -ου, τό, a feather, wing.
Ῥᾴδιος, -α, -ον, easy.
Σάμιος, -ου, ὁ, a Samian.
Σέβομαι, I venerate, worship.
Υἱός, -οῦ, ὁ, a son.
Ὥσπερ, even as.

EXERCISE 15.

Translate into English :—

1. Τοῖς Θεοῖς νεῴ κτίζονται. 2. Οὐ ῥᾴδιόν ἐστιν ἐπὶ κάλω βαίνειν. 3. Διώκομεν τοὺς λαγώς. 4. Ἀνδρόγεως ἦν ὁ Μίνω υἱός. 5. Οἱ λαγῴ θηρεύονται ὑπὸ τῶν θηρευτῶν. 6. Εὔχου τῷ ἵλεῳ Θεῷ. 7. Οἱ ἀετοὶ τοὺς λαγὼς ἐνεδρεύουσιν. 8. Σέβεσθε τοὺς ἵλεως θεούς. 9. Οἱ ἄνδρειοι ἀγήρων ἔπαινον λαμβάνουσιν. 10. Εὔχου τὸν Θεὸν ἵλεων ἔχειν. 11. Οἱ θεοὶ τοῖς ἀγαθοῖς ἵλεῳ εἰσίν. 12. Αἱ ἡδοναὶ ἀπάγουσι τὸν πλεῖστον λεὼν ὥσπερ αἰχμάλωτον.

EXERCISE 16.

Translate into Greek :—

1. You build temples to the gods. 2. Temples are built to the gods. 3. I build a temple to God. 4. They walk on ropes. 5. We hunt hares. 6. Hares are hunted. 7. The Samians have beautiful temples. 8. They worship the merciful God. 9. God is merciful (gracious) to good men. 10. Huntsmen hunt hares. 11. Menelaus obtains deathless praise.

THE THIRD DECLENSION.

The forms of the third declension in Greek are various, and can be learnt only by attentive practice. Some aid may, however, be given by means of classification.

The forms of the nominative singular, which are numerous, will appear as we proceed, and may therefore be omitted from this table of

THE CASE-ENDINGS OF THE THIRD DECLENSION.

	Singular.	*Plural.*	*Dual.*
Nom.		-ες	-ε
Gen.	-ος	-ων	-οιν
Dat.	-ῐ	-σι (-ν)	-οιν
Acc.	-ν or -α	-ας	-ε
Voc.		-ες	-ε

We need only note here that (except in neuter nouns and feminines in -α of the first declension) the nominative singular originally ended in the suffix -ς, which was appended to the stem. In nouns whose stem ends in a vowel, this -ς is always kept. In nouns whose stem ends in a consonant, it remains in many cases—sometimes driving out, sometimes coalescing with, the last consonant of the stem. Often it is itself dropped, and compensation for the loss is made in various ways (*e.g.*, by lengthening the last syllable of the stem); but often, also, no compensation is made, and the nominative thus shows the pure stem.

This is the explanation of the great variations which will be observed in the form of the nominative singular.

To form the oblique cases, the terminations given above are affixed to the stem, which may usually be found at once by removing the termination -ος from the genitive. What remains is the stem: *e.g.*, κόρακος (of a crow), the ος is the sign of the genitive, which being removed, leaves κορακ- as the stem. Add -ς to this, and we have the nominative κόρακ-ς = κόραξ.

Neuter nouns (which have nominative, accusative, and vocative alike) usually use the simple stem as nominative, with slight vowel change, or loss or euphonic alteration of the final letter: *e.g.*—

Stem.	*Nominative.*	*Genitive.*
γενεσ-,	γένος, race;	γενε(σ)-ος, γένους.
σωματ-,	σῶμα, body;	σώματ-ος.
τερατ-,	τέρας, a prodigy;	τέρατ-ος.

The accusative suffix -ν remains as ν only in nouns whose stem ends in a vowel, *e.g.*, in masculines

and feminines ending in -ις, -υς, -αυς, and -ους, the stems of which severally terminate in -ι, -υ, -αυ, and -ου: as—

Stem.	Nominative.	Accus.
πολι-,	πόλις, a city;	πόλιν.
βοτρυ-,	βότρυς, a bunch of grapes;	βότρυν.
ναυ-,	ναῦς, a ship;	ναῦν.
βου-,	βοῦς, an ox;	βοῦν.

If the stem ended in a consonant, the ν became a half-vowel sound, like our *-en* in *heaven*, *seven* (which are regularly scanned in poetry as one syllable), and being slurred in pronunciation, passed to a short α sound, and so, α instead of ν is found in the accusative, as φλεβ-, φλέψ, φλέβα, a vein; κορακ-, κόραξ, κόρακ-α, a raven; λαμπαδ-, λαμπάς, λαμπάδ-α, a torch.

The vocative is the same as the nominative, or as the stem. In the dative plural changes of the stem take place analogous to those which we have noticed in the nominative.

The third declension may be distinguished by the fact that the oblique cases have a syllable more than the nominative, while in the first and the second all the cases have the same number of syllables. Nouns which have the same number of syllables in all the cases are termed parisyllabic (in Latin par, *equal*), and nouns which lengthen the genitive and the cases derived from it are termed imparisyllabic (Latin im [in], *not*). Hence the first and second declensions are called parisyllabic, and the third is called imparisyllabic.

The nouns which follow the third declension may be arranged in three principal classes, according as their stem ends in—(i.) a consonant; (ii.) sigma, *s*; (iii.) a vowel. We shall treat of them under these three divisions:—

I. NOUNS WHOSE STEM ENDS IN A CONSONANT; and of these we give in the first place—

(*a*) *Nouns of which the Nominative gives the pure Stem.*

The case-endings are appended to the nominative.

Singular.

	The Song of Victory.	*Meadow.*	*Wild beast.*	*Nectar.*
Nom.	ὁ παιάν.	ὁ λειμών.	ὁ θήρ.	τὸ νέκταρ.
Gen.	παιᾶν-ος.	λειμῶν-ος.	θηρ-ός.	νέκταρ-ος.
Dat.	παιᾶν-ι.	λειμῶν-ι.	θηρ-ί.	νέκταρ-ι.
Acc.	παιᾶν-α.	λειμῶν-α.	θῆρ-α.	νέκταρ.
Voc.	παιάν.	λειμών.	θήρ.	νέκταρ.
		Plural.		
N.V.	παιᾶν-ες.	λειμῶν-ες.	θῆρ-ες.	νέκταρ-α.
Gen.	παιάν-ων.	λειμών-ων.	θηρ-ῶν.	νεκτάρ-ων.
Dat.	παιᾶ-σι.	λειμῶ-σι.	θηρ-σί.	νέκταρ-σι.
Acc.	παιᾶν-ας.	λειμῶν-ας.	θῆρ-ας.	νέκταρ-α.

Dual.

N.A.V.	παιᾶν-ε.	λειμῶν-ε.	θῆρ-ε.	νέκταρ-ε.
G.D.	παιάν-οιν.	λειμών-οιν.	θηρ-οῖν	νεκτάρ-οιν

The datives plural in full would be παιᾶνσι, λειμῶνσι, but the ν is dropped before -σι for the sake of euphony.

Ἀπόλλων, Apollo; Ποσείδων, Poseidon (in Latin, *Neptunus*), form their accusative singular also in -ω, Ἀπόλλω, Ποσείδω; and, with σώτηρ (a deliverer, saviour), have the last vowel of the stem shortened in the vocative, thus, ὦ Ἄπολλον, ὦ Πόσειδον, ὦ σῶτερ.

The neuters of this subdivision end in ρ (-αρ, -ορ, -ωρ, -υρ); τὸ πῦρ (fire) has τοῦ πυρός.

VOCABULARY.

Αἴδω, I sing.

Ἀναγιγνώσκω, I know again, recognise, read.

Βιβλίον, -ου, τό, a book (English, Bible).

Γιγνώσκω, I know.

Ἕλλην, ὁ, a Greek.

Ἡδέως, pleasantly, with pleasure.

Θαλία, -ας, ἡ, a rich feast.

Θάλλω, I bloom, flourish.

Κιθάρα, -ας, ἡ, a harp.

Κρατήρ, -ος, ὁ, a goblet, bowl.

Νίζω, I wash.

Πλάτων, -ος, Plato.

Πλεῖστοι, -ων, ὁ, very many.

Πῦρ,* -ός, το, fire.

Σπουδαῖος, -α, -ον, earnest, or excellent.

Τέρπω, I delight; τέρπομαι (with dat.), I am delighted.

Χείρ, -ός, ἡ, the hand; dat. χερσί; dat. dual, χεροῖν.

Χορός, -οῦ, ὁ, a choral dance.

Ψήν, -ός, ὁ, an insect.

EXERCISE 17.

Translate into English:—

1. Φεῦγε τοὺς θῆρας. 2. Χεὶρ χεῖρα νίζει. 3. Ἀπέχου τοῦ ψηνός. 4. Οἱ λειμῶνες θάλλουσιν. 5. Οἱ στρατιῶται ᾄδουσι παιᾶνα. 6. Ἐν πυρὶ χρυσὸν καὶ ἄργυρον γιγνώσκομεν. 7. Πολλοὶ παρὰ κρατῆρι γίγνονται φίλοι, πλεῖστοι δὲ ἐχθροί. 8. Οἱ ἄνθρωποι τέρπονται κιθάρᾳ καὶ θαλίᾳ καὶ χοροῖς καὶ παιᾶσιν. 9. Οἱ Ἕλληνες τὸν Ἀπόλλω καὶ τὸν Ποσείδω σέβονται. 10. Οἱ σπουδαῖοι μαθηταὶ τὰ τῶν Ἑλλήνων βιβλία ἡδέως ἀναγιγνώσκουσιν.

EXERCISE 18.

Translate into Greek:—

1. Avoid wild beasts. 2. They avoid a wild beast. 3. Wash the (your) hands. 4. Keep ye from insects. 5. A soldier is delighted with the cry of victory. 6. The cry of victory delights soldiers. 7. O earnest scholars, read the books of Plato. 8. The books of the Greeks are read by (ὑπό, gen.) earnest scholars. 9. We delight in beautiful meadows (dat.). 10. The meadows bloom. 11. Poets worship Apollo. 12. The poet worships Poseidon.

* Plural of second declension, πυρά.

KEY TO EXERCISES.

Ex. 3.—1. Yield not to force. 2. The lyre dissipates cares. 3. Friendship promises refuge and aid. 4. Care gnaws the heart. 5. Worship (cultivate) the Muses. 6. Do not believe false accusations. 7. Justice often yields to injustice. 8. We are often worn down by hard (severe) poverty. 9. Flee from (avoid) talkativeness. 10. Wickedness brings grief. 11. Luxury begets injustice and avarice. 12. Avoid luxury as a shame (or a bane). 13. True friendship arises through (from) virtue and intercourse.

Ex. 4.—1. Ἀπέχου τῆς βίας. 2. Ἀπέχεται τῆς βίας. 3. Οὐκ ἀπέχεται τῆς βίας. 4. Ἀπέχονται τῆς βίας. 5. Φεῦγε τὴν ἀδικίαν. 6. Φεύγετε τὴν ἀδικίαν. 7. Φεύγω τὴν ἀδικίαν ὡς μανίαν. 8. Ἡ βία λύπην ἐπάγει. 9. Διὰ δίκης γίγνεται ἡδονή. 10. Ἀληθιναὶ φιλίαι διὰ ἀρετῆς γίγνονται. 11. Ἡ καρδία πενίᾳ τείρεται. 12. Αἱ μέριμναι λύονται τῇ λύρᾳ.

Ex. 5.—1. Dishonour follows vice. 2. Bear poverty easily. 3. Thunder arises from shining lightning. 4. Virtue has excellent repute. 5. Regard for law sets right wrong judgments. 6. Justice begets justice, and injury injury. 7. Practise a good manner of living. 8. Restrain your tongue. 9. Fortune often has (brings) changes. 10. Bear ye poverty. 11. Splendid fortunes easily fall. 12. Bear thou fortunes (changes of fortune). 13. Virtue yields not to misfortunes (fortunes). 14. Abstain from hard (severe) cares. 15. The queen has a splendid kingdom.* 16. The robe is beautiful. 17. We have beautiful robes.

Ex. 6.—1. Φεύγετε τὰς μερίμνας. 2. Ἡ κακία τίκτει ἀτιμίαν. 3. Ἡ ἀρετὴ δόξῃ ἕπεται. 4. Ῥᾳδίως φέρουσι τὴν πενίαν. 5. Ἡ πενία φέρεται ῥᾳδίως. 6. Φέρετε τὴν πενίαν ῥᾳδίως. 7. Ἔχεις μεταβολάς. 8. Ἀπέχου τῆς κακίας. 9. Καλὴν στολὴν ἔχουσι. 10. Μὴ εἶκε τῇ τύχῃ. 11. Ῥᾳδίως εἴκουσι τῇ τύχῃ. 12. Κατέχετε τὴν γλῶσσαν. 13. Σκολιαὶ δίκαι εὐθύνονται.

Ex. 7.—1. Learn wisdom, O young man. 2. Politeness becomes a citizen. 3. We blame the talkativeness of a youth. 4. Avoid injustice, O citizen. 5. We admire the art of the sailor. 6. It is proper for auditors and spectators to keep silent. 7. O sailors, avoid the north wind. 8. The north wind often injures sailors. 9. O citizens, strive after virtue. 10. The Sybarites were voluptuaries. 11. Sailors have to do with the sea. 12. Flee, O Persian. 13. The Spartans have an honourable reputation. 14. I avoid a youth (who is) a voluptuary (or a voluptuous youth, or a youth given to pleasure). 15. Abstain from chatterers. 16. Hear, O master (sovereign lord).

Ex. 8.—1. Φεύγετε, ὦ Πέρσαι. 2. Πολίταις πρέπει ἡ ἀρετή. 3. Τὴν ἡσυχίαν ἄγειν προσήκει πολίτῃ. 4. Μανθάνετε, ὦ νεανίαι, τὴν σοφίαν. 5. Τὴν σοφίαν μανθάνουσι. 6. Τὴν σοφίαν μανθάνετε. 7. Τὴν σοφίαν μανθάνω. 8. Ἡ σοφία μανθάνεται. 9. Νεανίᾳ πρέπει ἡ εὐκοσμία. 10. Μὴ βλάπτε, ὦ βορέα, τοὺς ναύτας. 11. Φεῦγε, ὦ ναῦτα, τὸν βορέαν. 12. Ὁ βορέας φεύγεται. 13. Ὀρέγου, ὦ Σπαρτιᾶτα, τῆς δόξης. 14. Ἡσυχίαν ἄγετε, ὦ ἀδολέσχαι. 15. Ἀδολέσχου ἀπέχετε.

Ex. 9.—1. The bravery of the Spartans was admirable. 2. Flee, O young man. 3. Do you flee, O lovers. 4. Thieves are avoided. 5. Justice becomes judges. 6. It is the duty of soldiers to fight for the citizens. 7. Avoid liars. 8. It is the part of a master to take care of his domestics. 9. Do not trust a liar. 10. Art supports the artist. 11. From liars thieves are produced. 12. The Spartans were lovers of glory and honour. 13. Shipwreck often arises from the north wind. 14. You admire the skill of Hermes (Mercury).

Ex. 10.—1. Οἱ τῆς δόξης ἐρασταὶ οὐ φεύγονται. 2. Οἱ ψεῦσται τῆς ἀληθείας οὐκ εἰσὶν ἐρασταί. 3. Ἡ τοῦ Σπαρτιάτου ἀρετὴ θαυμαστὴ ἦν. 4. Μὴ πιστεύετε, ὦ Σπαρτιᾶται, τοῖς ψεύσταις. 5. Ἡ τοῦ Ἑρμοῦ τέχνη θαυμαστὴ ἦν. 6. Τὴν τῶν Σπαρτιατῶν ἀρετὴν θαυμάζουσι. 7. Φεῦγε ψεύστην, ὦ Σπαρτιᾶτα. 8. Ἔστι κριτοῦ ἐπιμέλεσθαι τοῦ οἰκέτου. 9. Οἰκετῶν ἐστι ἐπιμέλεσθαι τῶν δεσποτῶν. 10. Τεχνίτας τρέφουσιν αἱ τέχναι. 11. Τοῖς στρατιώταις προσήκει μάχεσθαι περὶ τῶν πολιτῶν. 12. Ἡσυχίαν ἄγε, ὦ βορέα. 13. Τὸν Ἑρμῆν θαυμάζω.

* In the Greek the distinction between the words for *queen* and *kingdom* is made merely by the accentuation. Thus, *queen*, *βασίλεια*, has the accent on the antepenult (the last syllable but two, reckoning from the end), whereas *βασιλεία*, *kingdom*, has the accent on the penult, or the last syllable but one.

ALGEBRA.—X.

[Continued from p. 159.]

SIMPLE EQUATIONS WITH FOUR OR MORE UNKNOWN QUANTITIES

203. If in the algebraic statement of the conditions of a problem, the original equations are more numerous than the unknown quantities, these equations will either be *contradictory*, or one or more of them will be *superfluous*.

Thus, the equations $3x = 60$, and $\frac{1}{2}x = 20$, are contradictory. For, by the first, $x = 20$; while, by the second, $x = 40$.

But if the latter equation be altered so as to give to x the same value as in the former, it will be useless in the statement of a problem. For nothing can be determined from the one which cannot be from the other.

Thus, in the equations $3x = 60$, and $\frac{1}{2}x = 10$, one is superfluous.

But if the number of independent equations produced from the conditions of a problem be *less* than the number of unknown quantities, the subject is not sufficiently limited to admit of a definite answer. If, for instance, in the equation $x + y = 100$, x and y are required, there may be fifty different answers. The values of x and y may be either 99 and 1, or 98 and 2, or 97 and 3, etc. For the sum of each pair of these numbers is equal to 100. But if there be a second equation which determines *one* of these quantities, the other may then be found from the equation already given. As $x + y = 100$, if $x = 46$, y must be such a number as added to 46 will make 100, that is, it must be 54; and no other number will answer this condition.

In most cases, also, the solution of a problem which contains many unknown quantities may be abridged by particular artifices in *substituting* a single letter for several.

EXAMPLE (3).—Suppose four numbers, u, x, y, and z, are required, of which the sum of the first three is 13, the sum of the first two and the last is 17, the sum of the first and the last two is 18, and the sum of the last three is 21.

Here, $u + x + y = 18$,
$u + x + z = 17$,
$u + y + z = 18$, and
$x + y + z = 21$, by the question.

Now, let S be substituted for the *sum* of the four numbers, that is, $u + x + y + z$. It will then be seen that of these four equations,

The first contains all the letters except z, that is,

$$S - z = 13;$$

The second contains all except y, that is,

$$S - y = 17;$$

The third contains all except x, that is,

$$S - x = 18, \text{ and}$$

The fourth contains all except u, that is,

$$S - u = 21.$$

Adding all these latter equations together, we have,

$$4S - z - y - x - u = 69, \text{ or}$$
$$4S - (z + y + x + u) = 69.$$

But $S = (z + y + x + u)$ by substitution.

Therefore, $4S - S = 69$, that is $3S = 69$, and $S = 23$.

Now, putting 23 for S, in the four equations in which it is first introduced, we have,

$$\left.\begin{array}{r} 23 - z = 13, \\ 23 - y = 17, \\ 23 - x = 18, \\ \text{and } 23 - u = 21. \end{array}\right\} \text{Therefore,} \left\{\begin{array}{l} z = 23 - 13 = 10, \\ y = 23 - 17 = 6, \\ x = 23 - 18 = 5, \text{and} \\ u = 23 - 21 = 2. \end{array}\right.$$

Contrivances of this sort for facilitating the solution of particular problems must be discovered by the student's own ingenuity and skill. They are of a nature not to be taught by a system of rules, but by practice and plodding industry, which is genius.

ALGEBRAICAL PROBLEMS.

204. In the following problems, the student may now employ two, three, or more unknown quantities in their solution, just as the nature of each may require; or he may still limit the number of the unknown quantities, by first supposing one unknown quantity, and then finding from the conditions of the question expressions for the other unknown quantities in terms of that which has been assumed.

EXERCISE 41.—ALGEBRAICAL PROBLEMS.

1. Find two numbers such that their sum shall be a, and their difference b.

2. Divide the number 20 into such parts, that three times the one added to five times the other will make 76.

3. Two gamesters, A and B, sat down to play. A had 80 guineas, and B had 60. After a certain number of games were won and lost between them, it was found that A had three times as many guineas as B. How many guineas did A win of B?

4. Find two numbers such that half the first and a third part of the second shall make 9; and that a fourth part of the first with a fifth part of the second shall make 5.

5. Divide the number 2 into two such parts that a third of the one added to a fifth of the other shall make [illegible].

6. Find three numbers such that the sum of the first and second shall be 7, the sum of the first and third 8, and the sum of the second and third 9; and give a general solution, by supposing these three sums to be a, b, and c respectively.

7. The sum of the three digits in a certain number is 16; the sum of the hundreds' digit and the tens' digit is to the sum of the tens' digit and the units' digit, as $4\frac{1}{2}$ is to $5\frac{1}{2}$; and if 198 be added to the number, the hundreds' digit and the units' digit will change places. What is the number?

8. Divide 72 into four such parts, that the first increased by 5, the second diminished by 5, the third multiplied by 5, and the fourth divided by 5, the sum, difference, product, and quotient, shall all be equal to one another.

9. A farmer hired 4 men and 8 boys for a week, and paid them in all £8; the next week he paid 7 men and 0 boys at the same rate each, and paid in all £10. How much did he pay each man and each boy by the week?

10. A father bequeathed £2,860 to his daughter and son in such a manner that for every half-crown the daughter had, the son should have a shilling? What were their shares.

11. A bill of £100 was paid in half-guineas and crowns; and 202 pieces of money were employed in the payment. How many pieces were there of each kind?

12. Find four numbers such that the sum of the first, second, and third, shall be 13; the sum of the first, second, and fourth, 15; the sum of the first, third, and fourth, 18; and the sum of the second, third, and fourth, 20.

13. Two numbers are to each other as 20 to 30; but if 0 be added to each, then the sums are to each other as 40 to 50. What are the numbers?

14. There are two numbers such that the greater is to the less as their sum is to 20, or as their difference is to 10. What are the numbers?

15. Three boys were playing at marbles. In the first game, A loses to B and C as many as each of these two had when they began; in the second game, B loses to A and C as many as each of these two had at the end of the first game; in the third game, C loses to A and B as many as each of these two had at the end of the second game. Each has now 16 marbles; how many had each at first?

16. A person goes to a coffee-house with a certain quantity of money in his pocket, where he spends 2 shillings; he then borrows as much money as he had left, and going to another coffee-house, he there spends 2 shillings also. Then, borrowing again as much money as was left, he went to a third coffee-house, where likewise he spent 2 shillings; and thus repeating the same at a fourth coffee-house, he then had nothing remaining. What sum had he at first, and what was he in debt?

17. A man with his wife and child dine together at an inn. The landlord charges 1 shilling for the child; for the woman as much as for the child and a quarter as much as for the man; and for the man as much as for the woman and child together. How much was that for each?

18. A cask which held 60 gallons was filled with a mixture of brandy, wine, and cider, so that the cider was 6 gallons more than the brandy, and the wine was as much as the cider and $\frac{1}{3}$ of the brandy. How much was there of each?

19. Says A to B, "If you give me 10 guineas of your money, I shall then have twice as much as you will have left;" but says B to A, "Give me ten of your guineas, and then I shall have three times as many as you." How many had each?

20. Three persons, A, B, and C, make a joint contribution, which in the whole amounts to £400; of which sum B contributes twice as much as A, and £20 more; and C as much as A and B together. What sum did each contribute?

21. The stock of three traders amounted to £760. The shares of the first and second exceeded that of the third by £240, and the sum of the second and third exceeded the first by £360. What was the share of each?

22. What two numbers are those which, being in the ratio of 3 to 4, their product is equal to 12 times their sum?

23. A certain company at an inn, when they came to settle their reckoning, found that had there been four more in company, they might each have paid a shilling less than they did; but that if there had been 3 fewer in company, they must each have paid a shilling more than they did. What, then, was the number of persons in the company, what did each pay, and what was the whole reckoning?

24. A farmer has two horses, and also two saddles, the one valued at £18, the other at £3. Now when he sets the better saddle on the first horse, and the worse on the second, it makes the first horse worth double the second; but when he places the better saddle on the second horse, and the worse on the first, it makes the second horse worth three times the first. What were the values of the two horses?

25. It is required to divide the number 24 into two such parts, that the quotient of the greater part divided by the less, may be to the quotient of the less part divided by the greater, as 4 to 1.

26. A cistern is to be filled with water from three different stop-cocks. From the first it can be filled in 8 hours, from the second in 10, and from the third in 14. How soon would they all together fill it?

27. A labourer engages to work for 3s. 6d. a day and his board, but to allow 9d. for his board each day that he is unemployed. At the end of 21 days he has to receive £3 2s. 9d. How many days did he work?

28. Three workmen are employed to dig a ditch of 191 yards in length. If A can dig 27 yards in 4 days, B 35 yards in 6 days, and C 40 yards in 12 days, in what time could they do it if they worked simultaneously?

29. A farmer wishes to mix 28 bushels of barley at 2s. 4d. a bushel, with rye at 3s. a bushel, and wheat at 4s. a bushel, so that the whole may consist of 100 bushels at 3s. 4d. a bushel. How much rye and wheat must he use for this purpose?

30. A sum of money was divided equally amongst a certain number of persons. Had there been three persons more, each would have received 1 shilling less; and had there been two persons fewer, each would have received 1 shilling more. Required the number of persons, and what each received.

31. How may a bill of £7 4s. be paid with half-guineas and crowns, so that twice the number of crowns may be equal to three times the number of half-guineas?

32. A person rows a distance of 20 miles and back in 10 hours, the stream flowing uniformly in the same direction all the time. He finds that, with the stream, he can row three miles in the same time that it takes him to row 2 miles against it. How long was he going with the stream, and how long against it?

33. A, B, and C possess certain sums of money, such that if A receive, in addition, half what B and C have, he will possess £a; if B receive, in addition, a third of what A and C have, he will possess £b; and if C receive, in addition, a fourth of what A and B have, he will possess £c. What sum has each?

34. All that is known respecting the coefficients a, b, and the quantity c, in the trinomial expression $ax^2 + bx + c$, is, that when 4 is put for x, the value of the expression is 42; that when 3 is put for x, its value is 22; and that when 2 is put for x, its value is 8. What are the values of the coefficients a, b, and the number c?

35. Five persons engage in play on the condition that he who loses shall give to each of the others as much as he already has. All lose in their turn, and yet at the end of the fifth game they all have the same sum, namely, £32. How much did each begin with?

36. Solve the general simultaneous equations to two unknown quantities, denoting the coefficients of x and y in the first equation by a and b, and the absolute term by c, and the coefficients of x and y in the second equation by d and e, and the absolute term by f; and let all the terms in both equations be positive.

37. A number consists of three digits, of which the difference between the first and second is the same as the difference between the second and third. If the number be divided by the sum of the digits, the quotient will be 26; but if 198 be added to it, the digits will be inverted. Required the number.

38. A person distributes a shillings among n persons, men and women; to the men he gives p pence each; to the women q pence each. Required the number of men and the number of women.

39. If from a vessel of wine containing a gallons, b gallons be drawn off, and the vessel then filled up with water, and this operation be repeated n times successively, find the quantity of wine remaining after these n operations are finished.

40. In a garrison of 2,744 men, there are two cavalry soldiers to twenty-five infantry, and half as many artillery as cavalry. Find the numbers of each.

41. A person dies worth £13,000; some of this he leaves to a charity, and twelve times as much to his eldest son, whose share is half as much again as that of each of his two brothers, and two-thirds as much again as that of each of his five sisters. Find the amount of the bequest to charity.

42. A farm of 270 acres is divided among A, B, and C: A has 7 acres to 11 acres of B, and C has half as much again as A and B together. Find the shares.

43. The length of a floor exceeds the breadth by 4 feet; if each had been increased by a foot, the area of the room would have been increased by 27 square feet. Find its original dimensions.

44. A sum of money was left for the poor widows of a parish, and it was found that if each received 4s. 4d. there would be 1s. over; whereas, if each received 5s., there would be 10s. short. How many widows were there, and what was the sum left?

45. There is a number consisting of two digits whose difference is two; and if it be diminished by half as much again as the sum of the digits, the digits will be inverted. Find it.

46. A person has travelled altogether 4,030 miles, of which he has gone *seven* miles by water to *four* miles on foot, and *five* miles by water to *two* on horseback. How many did he travel each way?

47. A cistern can be filled in 15 minutes by two pipes, A and B, running together: after A has been running by itself for 5 minutes, B is also turned on, and the cistern is filled in 18 minutes more. In what time would it be filled by each pipe separately?

48. A mass of copper and tin weighs 80 pounds, and for every 7 pounds of copper there are 3 pounds of tin. How much copper must be added to the mass that for every 11 pounds of copper there may be 4 pounds of tin?

49. A does $\frac{2}{5}$ of a piece of work in 10 days, when B comes to help him, and they take 3 days more to finish it. In what time would they have done the whole, each separately, or both together?

50. Divide £149 among A, B, C, and D, so that A may have half as much again as B, and a third as much again as B and C together; and D a fourth as much again as A and C together.

51. There are two silver cups, and one cover for both. The first weighs 12 ounces, and, with the cover, weighs twice as much as the other cup without it; but the second with the cover weighs a third as much again as the first without it. Find the weight of the cover.

52. A man could reap a field by himself in 20 hours, but with his son's help for 6 hours he could do it in 16 hours. How long would the son be in reaping the field by himself?

53. A grocer bought tea at 6s. 6d. per pound, and a third as many pounds again of coffee at 2s. 6d. per pound. He sold the tea at 8s. and the coffee at 2s. 3d., and so gained 5 guineas by the bargain. How many pounds of each did he buy?

54. Find a number composed of three digits, each greater by unity than that which follows it, so that its excess above one-fourth of the number formed by inverting the digits shall be 36 times the sum of the digits.

55. A and B have each a sum of money given them which will support their families for 10 and 12 days respectively; but A's money would support B's family for 15 days, and B's money would support A's family for 7 days, with 2s. 6d. over. What were the sums?

56. A person being asked how many ducks and geese he had in his yard, said, "If I had 8 more of each, I should have 8 ducks for 7 geese; and if I had 8 less of each, I should have 7 ducks for 6 geese." How many had he of each?

57. A man, woman, and child could reap a field in 30 hours, the man doing half as much again as the woman, and the woman two-thirds as much again as the child. How many hours would they each take to do it separately?

58. A merchant who allows £160 for his annual expenditure, increases his property every year by a fourth part, and at the end of two years is £900 richer than at first. What property had he at first?

59. A sold a certain number of tickets at a guinea each, and gave one-third of the produce to B; one-fourth of the remainder to C; and one-fifth of the last remainder to D; after which he had £210 remaining. How many did he sell?

ADDITION OF POWERS.

205. It is obvious that powers may be added, like other quantities, *by writing them one after another, with their signs.*

EXAMPLES.—The sum of a^3 and b^2 is $a^3 + b^2$; and the sum of $a^2 - b^n$ and $h^5 - d^4$ is $a^2 - b^n + h^5 - d^4$.

The same powers of the same letters are *like quantities*, hence their coefficients may be added or subtracted.

EXAMPLE.—Thus the sum of $2a^2$ and $3a^2$ is $5a^2$.

But powers of *different letters*, and *different* powers of the *same* letter, are *unlike quantities;* hence they can be added only by writing them down with their signs.

EXAMPLE.—The sum of a^2 and a^3 is $a^2 + a^3$.

It is evident that the square of a, and the cube of a, are neither twice the square of a, nor twice the cube of a.

EXAMPLE.—The sum of a^3b^n and $3a^5b^6$ is $ab^{3n} + 3a^5b^6$.

206. From the preceding principles we deduce the following

GENERAL RULE FOR ADDING POWERS.

If the powers are like quantities, add their coefficients, and to the sum annex the common letter or letters with their given indices.

If the powers are unlike quantities, they must be added by writing them one after another, without altering their signs.

EXERCISE 42.

1. To $-3x^6y^5$ add $-2x^6y^5$.
2. To $3b^m$ add $6b^m$.
3. To $3a^4y^n$ add $-7a^4y^n$.
4. To $-5a^3h^6$ add $6a^3h^6$.
5. To $3(a + y)^n$ add $4(a + y)^n$.
6. Add $5x(a - b)^3 + x(a - b)^3$ to $2x(a - b)^3 + 10x(a - b)^3$.
7. Add $3(x + y)^4 + 5a^2 - 4(x + y)^4$ to $10a^2 + 6(x + y)^4$.
8. Add $5a^2bc^3$, $3a^2bc^3$, a^2bc^3, and $2a^2bc^3$.
9. Add $a^2b^2 + x^6y^4 + a^2b^3$ and $-x^6y^4 + a^4b^6$.
10. Add $8a^3 + bc^2 + 5a^3 + 2bc^2$ and $a^3 + 5bc^2$ to $6a^3 + 2bc^2$.
11. Add $\frac{1}{3}(xy - cm)^6$, $3(xy - cm)^6$, $-\frac{1}{4}(xy - cm)^6$, and $\frac{3}{4}(xy - cm)^6$.

SUBTRACTION OF POWERS.

207. *Rule.—Subtraction of powers is performed in the same manner as addition, except that the signs of the subtrahend must be changed as in simple subtraction.*

EXAMPLE.—From $2a^4$ take $-6a^4$. *Ans.* $8a^4$.

EXERCISE 43.

1. From $-3b^n$ take $4b^n$.
2. From $3h^2b^5$ take $4h^2b^5$.
3. From a^3b^n take a^3b^n.
4. From $5(a - h)^5$ take $2(a - h)^5$.
5. From $6a(a + b)^4$ take $a(a + b)^4$.
6. From $17a^2x^3 + 5xy^2$ take $12a^2x^3 - 4xy^2$.
7. From $3a^3(b^2 - 8)^3$ take $a^3(b^2 - 8)^3$.
8. From $5(x^3 + y^4)^3 - 3(a^3 - b^3)^5$ take $-3(a^3 - b^3)^5 + 4(x^3 + y^4)^3$.
9. From $a^2b^3 + x^3y^4$ take $a^5b^6 - x^2y^3$.
10. From $2x(a - b)^3 + 3(a - b)^3$ take $x(a - b)^3 + 3(a - b)^3$.
11. From $\frac{1}{2}(x + y)^2 + \frac{1}{3}(a + b)^3$ take $\frac{1}{4}(x + y)^2 + \frac{2}{3}(a + b)^3$.

MULTIPLICATION OF POWERS.

208. *Powers* may be multiplied, like other quantities, by writing the factors one after another, either with or without the sign of multiplication between them.

EXAMPLES.—The product of a^3 into b^2, is a^3b^2; and a^3 into a^m, is a^ma^3.

If the quantities to be multiplied are *powers of the same root*, instead of writing the factors one after another, as in the last article, we may *add their exponents*, and the *sum* placed at the right hand of the root will be the *product* required.

The reason of this operation may be illustrated thus:—

$a^2 \times a^3$ is a^2a^3; but $a^2 = aa$; and $a^3 = aaa$; and $aa \times aaa = aaaaa = a^5$. The sum of the exponents $2 + 3$ is also 5; so $d^m \times d^n = d^{m+n}$.

N.B.—The same principles hold true in all other powers of the same root.

209. Hence we deduce the following

GENERAL RULES FOR MULTIPLYING POWERS.

Powers of the same root may be multiplied by adding their exponents.

If the powers have coefficients, these must be multiplied together, and their product prefixed to the common letter or letters.

Powers of different roots are multiplied by writing them one after another, either with or without the sign of multiplication between them.

EXAMPLES.—Thus $a^2 \times a^6 = a^{2+6} = a^8$; and $x^3 \times x^2 \times x = x^{3+2+1} = x^6$.

The rule is equally applicable to powers whose exponents are *negative*; *i.e.*, to reciprocal powers.

EXAMPLES.

Thus $a^{-2} \times a^{-3} = a^{-5}$. That is, $\frac{1}{aa} \times \frac{1}{aaa} = \frac{1}{aaaaa}$.

If $a + b$ be multiplied into $a - b$, the product will be $a^2 - b^2$; that is—

The product of the sum and difference of two quantities is equal to the difference of their squares.

This is an instance of the facility with which *general truths* are demonstrated in algebra.

If the sum and difference of the *squares* be multiplied, the product will be equal to the difference of the *fourth* powers; that is, $(a^2 + b^2) \times (a^2 - b^2) = (a^4 - b^4)$.

EXERCISE 44.

1. Multiply h^2b^n into a^4.
2. Multiply $3a^6y^2$ into $-2x$.
3. Multiply dh^3x^n into $4by^4$.
4. Multiply $a^2b^3y^2$ into a^3b^2y.
5. Multiply $4a^n$ into $2a^n$.
6. Multiply $3x^4$ into $2x^3$.
7. Multiply b^2y^3 into b^4y.
8. Multiply $a^2b^3y^4$ into a^3b^2y.
9. Multiply $(b + h - y)^n$ into $(b + h - y)$.
10. Multiply $x^3 + x^2y + xy^2 + y^3$ into $x - y$.
11. Multiply $4x^2y + 3xy - 1$ into $2x^3 - x$.
12. Multiply $x^3 + x - 5$ into $2x^2 + x + 1$.
13. Multiply y^{-n} into y^{-m} into y^{-4}.
14. Multiply a^{-2} into a^{-3} into a^{-5}.
15. Multiply a^{-2} into a^{-3} into $-a^{-5}$.
16. Multiply a^{-n} into a^m into $-a^{2m}$.
17. Multiply y^{-2} into y^2 into $-y^{-n}$ y^{-3}.
18. Multiply $(a - y)$ into $(a + y)$.
19. Multiply $(a^2 - y^2)$ into $(a^2 + y^2)$.
20. Multiply $(a^4 - y^4)$ into $(a^4 + y^4)$.
21. Multiply $a^2 + a^4 + a^6$ into $a^2 - 1$.
22. Multiply $3a(x^2 - y^3)^3$ into $2a(x^2 - y^3)^4$.
23. Multiply $\frac{1}{2}(a^2 + b^3)^3$ into $\frac{1}{2}(a^2 + b^3)^2$.
24. Multiply $a^3 - b^2$ into $a^3 + b^2$.
25. Multiply $x^3 + x^2y + xy^2 + y^3$ into $x + y$.
26. Multiply $a^4 - 2a^3b + 4a^2b^2 - 8ab^3 + 16b^4$ into $a + 2b$.
27. Multiply $a^2 + b$ into $a^2 - 8$.

DIVISION OF POWERS.

210. Powers may be divided, like other quantities, by rejecting from the dividend a factor equal to the divisor; or by placing the divisor under the dividend, in the form of a fraction. Thus the quotient of a^3b^2 divided by b^2 is a^3.

EXAMPLE.—The quotient of a^5 divided by a^3 is $\frac{a^5}{a^3}$. But this is equal to a^2. For in the series

$$a^4, a^3, a^2, a^1, a^0, a^{-1}, a^{-2}, a^{-3}, a^{-4}, \text{etc.},$$

if any term be divided by another, the index of the quotient will be equal to the *difference* between the index of the dividend and that of the divisor.

Thus $a^5 \div a^3 = \frac{aaaaa}{aaa} = a^2$; and $a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$.

Hence we deduce the following

GENERAL RULE FOR DIVIDING POWERS.

A power may be divided by another power of the same root by subtracting the index of the divisor from that of the dividend.

If the divisor and dividend have coefficients, the coefficient of the dividend must be divided by that of the divisor.

If the divisor and dividend are both compound quantities, the terms must be arranged, and the operation conducted in the same manner as in simple division of compound quantities.

EXAMPLE.—Thus $y^3 \div y^2 = y^{3-2} = y^1$. That is, $\frac{yyy}{yy} = y$.

[The above rule is equally applicable to reciprocal powers.]

EXERCISE 45.

1. Divide $9a^3y^4$ by $-3a^3$.
2. Divide $12b^3x^n$ by $2b^3$.
3. Divide $a^2b + 3a^2y^4$ by a^2.
4. Divide $d \times (a - h + y)^5$ by $(a - h + y)^3$.
5. Divide a^{n+8} by a.
6. Divide x^n by x^n.
7. Divide y^{2m} by y^m.
8. Divide b^6 by b^5.
9. Divide $8a^{n+m}$ by $4a$
10. Divide a^{n+3} by a^2.
11. Divide $12(b+y)^n$ by $3(b+y)^3$.

ROOTS.

211. If we resolve b^3, or bbb, into equal factors, viz., b, b, and b, each of these equal factors is said to be a root of b^3. So if we resolve 27 into its three equal factors, as $3 \times 3 \times 3$, each of these equal factors is said to be a root of 27. And when any quantity is resolved into any number of equal factors, each of those factors is said to be a root of that quantity.

A root of a quantity, then, is a factor which, multiplied into itself a certain number of times, will produce that quantity.

The *number of times* the root must be taken as a factor to produce the given quantity, is denoted by the *name* of the root.

Thus 2 is the *fourth* root of 16; because $2 \times 2 \times 2 \times 2 = 16$, where 2 is taken *four* times as a factor to produce 16.

So a^3 is the *square* root of a^6; for $a^3 \times a^3 = a^6$.

Powers and *roots* are correlative terms. If one quantity is a *power* of another, the latter is a *root* of the former. As b^3 is the cube of b, so b is the cube root of b^3.

There are two methods in use for expressing the roots of quantities; one by means of the radical sign $\sqrt{}$, and the other by a fractional index. The

latter is generally to be preferred; but the former has its uses on particular occasions.

When a root is expressed by the radical sign, the sign is placed before the given quantity, in this manner, $\sqrt{a}$.

Thus $\sqrt[2]{a}$ is the 2nd, or square root of a; $\sqrt[3]{a}$ is the 3rd, or cube root.

The *figure* placed over the radical sign denotes the *number of factors* into which the given quantity is resolved; *i.e.*, the *number* of *times* the *root* must be taken as a *factor* to *produce* the *given quantity*.

Thus $\sqrt[3]{a^2}$ shows that a^2 is to be resolved into two factors, and $\sqrt[3]{a^2}$ into three factors, and $\sqrt[n]{a^n}$ into n factors.

The figure for the *square* root is commonly omitted, and the radical sign is simply written before the quantity. Thus $\sqrt{a^2} = \sqrt[2]{a^2}$.

When a figure or letter is *prefixed* to the radical sign without any character between them, the two quantities are to be considered as *multiplied* together.

Thus $2\sqrt{a}$ is $2 \times \sqrt{a}$; that is, 2 multiplied into the root of a; or, which is the same thing, *twice* the root of a.

And $x\sqrt{b}$ is $x \times \sqrt{b}$, or x times the root of b.

When no coefficient is prefixed to the radical sign, 1 is always understood; $\sqrt{a}$ being the same as $1\sqrt{a}$; that is, *once* the root of a.

The *cube* root of a^6 is a^2; for $a^2 \times a^2 \times a^2 = a^6$.

Here the index is divided into *three* equal parts, and the quantity itself resolved into three equal factors.

The square root of a^2 is a^1 or a; for $a \times a = a^2$.

By extending the same plan of notation, *fractional indices* are obtained.

Thus, in taking the square root of a^1 or a, the index 1 is divided into two equal parts, $\frac{1}{2}$ and $\frac{1}{2}$; and the root is $a^{\frac{1}{2}}$.

On the same principle, the cube root of a is $a^{\frac{1}{3}} = \sqrt[3]{a}$.

The nth root, is $a^{\frac{1}{n}} = \sqrt[n]{a}$, etc.

Every root, as well as *every power of* 1, is 1; for a root is a factor which, multiplied into itself, will produce the given quantity. But no factor except 1 can produce 1, by being multiplied into itself.

So that 1^n, 1, $\sqrt{1}$, $\sqrt[n]{1}$, etc., are all equal.

Negative indices are used in the notation of roots, as well as of powers.

Thus $\frac{1}{a^{\frac{1}{2}}} = a^{-\frac{1}{2}}$; $\frac{1}{a^{\frac{1}{3}}} = a^{-\frac{1}{3}}$; $\frac{1}{a^{\frac{1}{n}}} = a^{-\frac{1}{n}}$; $\frac{1}{a^{\frac{1}{mn}}} = a^{-\frac{1}{mn}}$.

POWERS OF ROOTS.

212. In the preceding examples of roots, the numerator of the fractional index has been a *unit*. There is another class of quantities, the numerators of whose indices are *greater* than 1; as $b^{\frac{3}{2}}$, $c^{\frac{3}{4}}$, etc. These quantities may be considered either as *powers* of *roots*, or *roots* of *powers*.

N.B.—In all instances, when the root of a quantity is denoted by a fractional index, the *denominator*, like the figure over the radical sign, expresses the *root*, and the *numerator* the *power*. Thus $a^{\frac{1}{3}}$ denotes the *cube* root of the *first* power of a; *i.e.*, that a is to be resolved into three *equal factors*; for $a^{\frac{1}{3}} \times a^{\frac{1}{3}} \times a^{\frac{1}{3}} = a$. On the other hand, $c^{\frac{3}{4}}$ denotes the *third* power of the *fourth* root of c, or the *fourth* root of the *third* power. One expression is *equivalent* to the other.

The value of a quantity is not altered by applying to it a fractional index whose numerator and denominator are equal. Thus, $a = a^{\frac{2}{2}} = a^{\frac{3}{3}} = a^{\frac{n}{n}}$. For the denominator shows that a is resolved into a certain number of factors; and the numerator shows that all these factors are multiplied together in $a^{\frac{n}{n}}$. On the other hand, when the numerator of a fractional index becomes equal to the denominator, the expression may be rendered more simple by *rejecting* the index.

Instead of $a^{\frac{n}{n}}$, we may write a.

The index of a power or root may be exchanged for any other index of the *same value*.

Instead of $a^{\frac{2}{3}}$, we may put $a^{\frac{4}{6}}$.

For in the latter of these expressions, a is supposed to be resolved into *twice* as many factors as in the former; and the numerator shows that *twice* as many of these factors are to be multiplied together. Hence the value is not altered.

From the preceding article it will be easily seen that a fractional index may be expressed in *decimals*.

EXAMPLE.—Thus $a^{\frac{1}{2}} = a^{\frac{5}{10}}$, or $a^{0.5}$; that is, the square root is equal to the fifth power of the tenth root.

In many cases, however, the decimal can be only an *approximation* to the true index.

EXAMPLE.—Thus $a^{\frac{1}{3}} = a^{0.3}$ nearly, or $a^{0.33333}$ more nearly.

In this manner the approximation may be carried to any degree of exactness which is required.

N.B.—These decimal indices form a very important class of numbers, called *logarithms*.

EXERCISE 46.

1. What is $a^{\frac{2}{3}}$ equal to?
2. What is $x^{\frac{3}{5}}$ equal to?
3. What is $y^{\frac{3}{4}}$ equal to?
4. What is $b^{\frac{7}{5}}$ equal to?
5. Write the 5th root of the 4th power of a.
6. Write the 7th power of the 9th root of d.
7. Express $a^{\frac{1}{4}}$ in decimals.
8. Express $a^{\frac{3}{5}}$ in decimals.
9. Express $a^{\frac{7}{4}}$ in decimals.
10. Express $a^{\frac{5}{6}}$ in decimals.
11. Express $a^{\frac{11}{4}}$ in decimals.
12. Express $a^{\frac{7}{8}}$ in decimals.
13. Express $a^{\frac{5}{8}}$ in decimals.
14. Express $a^{\frac{11}{7}}$ in decimals.

KEY TO EXERCISES.

EXERCISE 36.

1. $x = 5$, and $y = 6$.
2. $x = 10$, and $y = 8$.
3. $x = 6$, and $y = 4$.
4. $x = 15$, and $y = 20$.
5. $x = 11$, and $y = 9$.

EXERCISE 37.

1. $x = 5$, and $y = 2$.
2. $x = 2$, and $y = 10$.
3. $x = 4$, and $y = 20$.
4. $x = 8$, and $y = 12$.
5. 100 and 140 miles.
6. A = 49 years, and B = 21 years.
7. 15 the greater, and 10 the less.

EXERCISE 38.

1. $x = 6$, and $y = 4$.
2. $x = 8$, and $y = 6$.
3. $x = 12$, and $y = 2$.
4. $x = 7$, and $y = 3$.
5. 11,111 = greater army, and 9,999 = smaller army.
6. 120 the greater, and 104 the less.
7. 60ft. the lower portion, 48ft. the upper portion, 108ft. the total height.
8. 10 and 2.
9. 3 and 2.
10. 20 and 12.
11. 32 and 20.
12. 24.
13. 63.
14. 78 gallons of brandy, and 66 gallons of gin.

EXERCISE 39.

1. $x = 6$, $y = 4$, and $z = 2$.
2. $x = \frac{1}{2}(a + b - c)$, $y = \frac{1}{2}(a - b + c)$, and $z = \frac{1}{2}(-a + b + c)$.
3. A's money = 64 dollars, B's = 72, and C's = 84.
4. A's distance is 16 miles, B's = 9, and C's = 7.
5. $x = 24$, $y = 60$, and $z = 120$.
6. $x = 30$, $y = 20$, and $z = 10$.

EXERCISE 40.

1. [illegible]
2. 18, 22, 10, and 40.
3. 50, 65, and 75.
4. [illegible]

WATER-COLOUR DRAWING.—II.

[*Continued from p. 171.*]

THE USE OF THE BRUSH.

ONE of the most important qualifications necessary for producing a clever and effective picture is a thorough command of the use of the brush. Very frequently the cause of failure in painting is not so much in mistaking the exact colour, as an indifference shown for, or an incapacity of representing, the exact form. Where there is an imperfect ability to draw the object, from the first arrangement to its minutest details, there must necessarily be a corresponding deficiency in the power of execution required with the brush; and it must be borne in mind that everything introduced into a picture must bear its own individual character. The porte-crayon and the brush are the only instruments we have for representing form, and although this is a duty shared by both, yet they have each their own peculiar mode of fulfilling it. The greater freedom of execution afforded in the handling of the brush is a great temptation to many young painters to place too much dependence upon it for continuing that which the pencil alone ought to have completed, and when this is the case one cannot be surprised at failures; and though we allow that the successful handling of the brush is the result of careful and correct drawing, at the same time, and for this very reason, we maintain that the power thus given by the pencil must be further cultivated to enable us to give effect to innumerable particulars which can best be done by the brush alone. Its fine point can, by gentle pressure, be spread out, and made capable of describing broad markings and effective indications in a way that can by no other instrument possibly be produced; but to handle it in such a manner as to obtain its fullest capabilities must be the result of much practice, and a correct knowledge of the object to be painted. The duty of the brush is to take up the work where the pencil stops and can go no further. The latter must first define the boundaries and extent of the masses, and all important details, but the brush must fill them in, and, in so doing, lend its assistance to bring out all the characteristic particulars which the pencil has indicated. There must be neither hurry nor hesitation; the brush must be charged according to the extent of the part to be covered, well filled when the space to be covered is large, and partly exhausted on the blotting-pad when there is little to do beyond sharpening out particulars with washes and touches of shadow tint or semi-tone, thus adding brilliancy to the lights by contrast, as well as a means for bringing into notice all less important details, which contribute their share to the work, and also the innumerable accidental projections to be found on uneven surfaces. When washing in broad flat tones, the brush may be held at an angle of about 40°; but for touching in, or making out details, it must be held in an almost perpendicular position, so that we may have an entire command of the point; in such a position, the point may be guided in all directions with the greatest freedom. The above remarks have especial reference to the kind of details which must engage our attention, for where there are portions of colour or tone which are in decided contrast with the surrounding parts, and consequently have a distinct recognition, they must be carefully considered both as to their forms and tones, or we should be painting unmeaning patches very much out of place; for we must always bear in mind that wherever we find a great variety of tones and tints there are especial reasons for them, which the painter must endeavour to understand and account for, or, with all his efforts, he will fail in giving the proper effect as it is in Nature.

We will now direct our attention to the accompanying illustrations. As this lesson is intended as an exercise in the use of the brush, we will still

confine ourselves to the use of sepia. After the drawing has been made, commence the sky with a moderately light tone of colour, using the brush freely, and with a light hand, across the paper, directing it in such a way as *to preserve the forms and masses of the light clouds.* There must be omitted. In Fig. 4 the process is further carried out by the addition of shadows. Let the sides turned away from the light—viz., at *b b*—be painted with a somewhat darker tone than the tone first used, and break off the edges approaching the light in the same way as before. Our

Fig. 3.

plenty of colour in the brush, but it must not be overcharged, as too much will cause blots; too little will not only dry before we are prepared to soften some of the edges, but will very probably produce out-shades and other disagreeable results that will make the sky look hard and heavy. The brush moderately filled when dragged over the paper will leave many spaces of various forms and sizes untouched; with judicious management, the lights thus left may be converted into bright airy clouds floating across the sky represented by the colour. Whilst it is wet, wash the brush, draw it across the blotting-pad, and soften off most of the under edges of these light spaces; some of those, in both figures, are marked *a* upon the edges to be washed off. We advise our pupils to practise several times this method of partly floating and partly dragging in a sky, either from Nature or (as the colour we are using is sepia only) from good engravings: much profit may be derived from these, as our remarks apply especially to the forms of clouds and the proportions of light and shade employed in representing them. In Fig. 3 only one tone is used in the sky, shadows being pupils will soon find out that to break off the edges is not to wash them uniformly down to a smooth graduated shade. This would make the clouds too solid, but by breaking the edges with a clean brush (moist, but not too wet, as the water would run into the colour, and spoil the whole), we produce, without any seeming effort on our part, other intermediate tones in unison with the extremes, as well as many bright and sharp prominences peculiar to clouds. On the lower part of the sky, as we approach the horizon, we may pass some light tone nearly over the whole. This may be a broken one also, but no extremes of light and shade must be introduced here, as they would destroy all aërial perspective by bringing the lower parts too forward. The only exception to this last remark is in the case of evening effects. When the sun is low, then its rays illuminate the lower clouds with greater brilliancy. The distant hills of Fig. 4 are painted with the same tone as the upper part of the sky, the middle distance with nearly the same colour as the cloud shadows, and the foreground with a darker mixture. The light near the foreground is the

effect of the reflected light of the sky upon the water, and it gives us the opportunity of bringing the light down into the landscape. The distant hills of Fig. 3 must be treated similarly to those of Fig. 4. The side of the building in shadow is done with a very slightly darker colour, and as the sun at the same time into the broad shadow on the front. Breaking the tints, especially over old walls, has an excellent effect in helping to give that variety of colour and semi-tone on the surface which is so common to them. As the light of the sky must be reflected in the water in front, to give the *appearance*

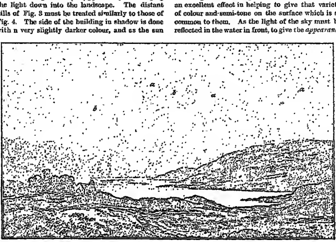


Fig. 4.

is behind the picture—that is, the building is between the sun and the spectator, the whole front of the building will be in shadow, having its cast shadow on the ground before it. This latter may be done with the same colour, although afterwards it will be necessary to make it darker than the broad shadow, as the light reflected from the ground will brighten the broad shadow of the building. Some of the more general tones of the foreground may be painted at the same time. The hedgerow in the middle distance must partake of the same colour as the building, both being about the same distance from the front. Make a darker tint than has been yet used for the tree, with which the greater portion must be made out, leaving the sky to appear through the stems and foliage. From the position of the sun, there will be very little of the tree in positive light, excepting some of the tips of the upper branches. These must be painted with a lighter colour. As the tone of the building must altogether be darker than the sky, wash a light tint over the side of the tower and the roof, bringing down the same colour of water, the whole of the ground near it before the building, and in the foreground, may receive a general wash, similar to the lighter parts of the building. The reflection of the building will materially help in giving character to the water. The making out of the reflection should be done with the shadow colour of the building, drawing the brush downwards from the back, being careful to make the end of the reflection perpendicular to the end of the object reflected, and, before it is quite dry, take a somewhat darker tone, and intersperse it in the same perpendicular manner amongst those parts of the reflection which require it, being guided by the corresponding parts in the building. Lastly, the extreme depths of colour must be confined to the tree and the foreground, which must be executed chiefly in sharp touches, regarding the forms of the objects and their accompanying details. This kind of treatment will give contrast to the lights, and decision of form and character to everything placed prominently in the picture.

As we have often remarked in our lessons in Drawing, our pupils must not be disheartened if

they do not succeed in producing a fair copy of our illustrations even after many attempts: they must be content to persevere, bearing in mind that perseverance never fails to yield its fruits in due season. It is also almost needless to point out that copies of our cuts should not be made of the same size, but on a scale giving a picture of at least four times the area.

After our pupils have accustomed themselves in some degree to handling the brush, and, from the use of sepia, have gained fresh experience in discriminating and representing the tones arising from the innumerable and ever-varying effects caused by light and shade, we now recommend them to apply to colour the principles we have endeavoured to explain. Here we reach a point where many of our difficulties begin. It is not an easy task to lay down rules by which we are to be guided in conducting a picture through all its stages of progress, and enumerate and specify its colours, tones, and tints, for if it were possible to give a recipe for painting one picture, it is more than probable that it would not be found equally applicable to another. When we reflect that there is no restriction to the changes which are continually passing over the same object, and add to this, in many cases, the multiplied varieties of that object, it will be readily acknowledged that the attempt to write special rules for all cases, or even for a few, would be a failure; consequently, we must again make our starting-point from first principles, and endeavour to unite them with much that is generally practical, that our pupils may be led to make their own deductions, and thus carry their experience beyond the point where specific rules have little advantage.

There are but three primitive colours—red, blue, and yellow; all others are but proportionate combinations of these three: for example, red and blue mixed make purple, blue and yellow make green, and red and yellow make orange. These, again, which are called secondary colours, may be respectively united and further neutralised; and this art of neutralising and combining in accordance with the colour of the object to be imitated, and the apparent change of that colour as it yields to the light, or is acted upon by reflection from another adjacent colour, is the object which the student desires to accomplish. But our difficulties are greatly diminished by having the colour-box supplied with modifications of these colours under distinct names. Independently of the many different reds, blues, and yellows, from which we derive so much assistance on account of their diversity—as one red in some cases is preferable to another, and one blue to another—we have in addition to these a great variety of browns, which furnish numerous tints of the greatest service, and still further when we combine them with one or other of the primitive colours. Let the pupil unite blue with burnt sienna, or with brown pink, or with sepia, and he will find that he produces greens much more sombre and deeper in tone than the composition of blue with any of the yellows. The latter are more serviceable in the lights, the former in the shadows; but this will engage our attention again in some practical application.

We shall very frequently have occasion to use the terms *warm* and *cool* in reference to colour, therefore it is necessary to explain them, and show how these changes are effected. The *warm* tones are obtained by adding a greater proportion of red or yellow, whilst the *cool* ones are produced by an increase of blue; but even these, the primitive colours, have their gradations of tone. Light red, which is nothing more than burnt yellow ochre, is warmer than some of the lakes. Of the yellows, cadmium yellow is more intense than gamboge, and it will be seen that when each of these yellows is separately mixed with blue to produce green, the latter will make a much cooler green than the former. All these combinations, and many more of like character, will form an important study for the pupil, and it will be his policy to make himself fully acquainted with them, for, as he proceeds, experience will teach him that the more he is familiar with the capabilities of colour, or, in other words, what his colours are able to produce, he will the more readily comprehend, and be better able to imitate, the innumerable degrees of tone and tint as they appear to him in Nature. Similarly, greys and all neutral tones may be made warmer or cooler as the occasion requires. This is one of the most important studies of the painter. His greatest difficulties with regard to colour will arise in the use of greys, and in harmonising neutral tones. There is no limit to their gradations, and in proportion as they are understood and applied, so will the ability of the painter and the merit of his work be estimated. Nobody has yet painted them all; and when we say one artist is greater than another in the use of colour, it is principally on account of his greater comprehension of the use of greys, and his power of adapting them to the colours he uses, so that, by skilful management, the greys may enhance the purity and brilliancy of the positive colours according as the character of the subject upon which he employs them requires it. We will give one example where the same grey placed by the sides of extreme warm and cool colours will appear from the connection to be so widely different that it would scarcely be thought to be the same tint, and it will show how

colours influence one another. We ask our pupils to try the following experiment:—Take three saucers, and in one mix a rather strong tint of Prussian blue, in another cadmium yellow and crimson lake, in the third prepare a grey tint, composed of cobalt and a little light red; then take colours: crimson lake, burnt sienna, yellow ochre, cadmium yellow, gamboge, brown pink, sepia, cobalt, and indigo. That is, we will restrict ourselves to these colours, for with them the theory of light and shade, the contrast of warm and cold colours in their arrangement and general effects,

Fig. 5.

two pieces of paper, and cover the upper part of one with the Prussian blue, and the upper part of the other with the cadmium yellow and lake. When dry, continue from the edge of each colour a wash of the grey; it will be seen that the latter in juxtaposition with the cool colour will appear to be warm, and the same in alliance with the warm colour will appear to be cold, and the two colours respectively will seem to be made more blue or yellow, that is, more intense than if painted alone. If Indian ink be used instead of grey, the contrast is even more striking. Here, then, is the first principle upon which is founded the theory of the use of grey in union with the primary colours in order to increase their brilliancy by the contrast.

The subject we have chosen for our lesson (Fig. 5), *evening* or *sunset*, is not an elaborate one, nor do we intend to go beyond the leading principles to be observed in painting it. It will require very few can be sufficiently explained, and leave for private study all minor details in relation to colour that arise from various accidental circumstances, which are found to differ in every subject, though every subject contains them more or less. If our pupils can accompany us only to the extent we can possibly attempt to lead them with merely written instructions, we shall have so far assisted them that they may afterwards pursue their course, depending upon their own observations from Nature, bearing in mind that we have endeavoured to impress upon them that warm colours will appear more so when contrasted by cold ones, and that light will appear brighter in contrast with dark, provided that the semi-tones are judiciously managed. Thus, by contrast, not necessarily violent, brilliancy and force are increased.

We will now proceed with our subject, and commence with an old caution respecting the outline—

let it be made perceptible, and no more. We must begin with the sky. Turn the drawing upside down, and let it be inclined so that what is really the bottom of the picture is now from its position the most elevated, as the positions of the letters A and B explain. Mix in a saucer a less than middle tint of cadmium yellow. This powerful yellow will be the most suitable for our purpose. Begin with a wash of this tint from the edge A A as far as B B, to the upper line of the hills, afterwards increase its strength a little, and then let it become a graduated tint from E E through the rest of the sky. It is always safe for a beginner not to make his tints too strong, as they can be repeated if necessary. When dry, turn the picture back into its proper position, still preserving the inclination; and commence from D D with a wash composed of cobalt blue and a little lake. This must also be graduated, and cease at about E E. It must be observed that the blue tint must be a light one, for although the previous yellow mixture has been *decreasing* in depth to the top of the picture, the blue tint must not be carried down to the same extent, as it would neutralise or destroy the purity of the yellow, and again, when passing over the yellow with the blue, it must be done carefully, with one wash, for the oftener the brush passes across an under colour, the danger of washing it up is increased. Cover the mountains with the blue tint with which the upper part of the sky was painted, and when dry repeat it again, excepting those parts which catch the light on the summits; wash off the *edge* (remember, the edge only) at the base, clean the brush, and take the cadmium tint of the sky and paint the water. The whole of the foreground, except the stream and the lighter foliage, may be passed over with a light mixture of burnt sienna and yellow ochre. The shadows in the foreground must be made with cobalt blue, lake, and a little sepia. Let the blue and lake be in *greater* proportion than the sepia, because this purple grey upon the warm ground previously painted with burnt sienna and ochre will be sufficiently neutralised with only a small addition of sepia. The broad shadows of the dark tree may be passed over with the same grey. If, as the picture proceeds, it is discovered that the sky is too low in tone, mix a light tint of cadmium yellow and lake, and pass it over the whole of the sky, from the top to the edges of the hills. Should it be found when dry that the last wash has accidentally gone beyond the edge of the hills so as to produce a heavy margin, wet the parts with a clean brush, press a piece of blotting paper upon them, and rub the parts very gently with a folded silk handkerchief. If carefully done, the original ground will be restored without any injury. This last tint may most likely be required over the water also; in this case, break it off into the lights in the foreground. If the last wash upon the sky has proved satisfactory, add to the same tint a little more lake, and with a light hand touch in the clouds. As they ascend into the upper part of the sky, add some of the grey tint to the last, and paint the darker clouds. Before painting the trees, do something more to the foreground. Mix a little indigo with gamboge and yellow ochre, and paint *the lights only* of the grass and herbage, etc., close to the edges of the shadows before painted. Indigo and brown pink will be useful to define the character of the foreground by giving a little more decision to the forms of the leaves, bracken, and weeds, without destroying the cool shadows that must be in contrast and give strength to the warm lights. The dark trees may be painted first with brown pink only, preserving the openings to the sky; afterwards they must be made out with indigo and brown pink. These two colours combined compose a rich dark green, that can be made either warmer or cooler according to the proportion of indigo or brown pink added to it. Keep the ground of the shadows cool, upon which make out with the dark warm green all particulars approaching the light. The trees on the left partake of the colour of the sky and dark tree united. We have introduced the white sail of a boat under the hills to assist the colour of the distance. To do this, draw the form of the sail with a wet brush, take up the superfluous water with blotting paper, and then rub the part with a bit of stale bread-crumb. The hull of the boat must be of the grey distance. The edges of the shore, and the sides of the stones which are away from the light, are painted with the grey tint, some parts darker, others lighter. These general directions may be closely followed whilst repeating the practice of this lesson a few times. Then the pupil will begin to see how colours can assist or weaken one another, so that by degrees he will be induced to apply them to a much greater extent than can be explained in these pages, with less fear of any serious failure.

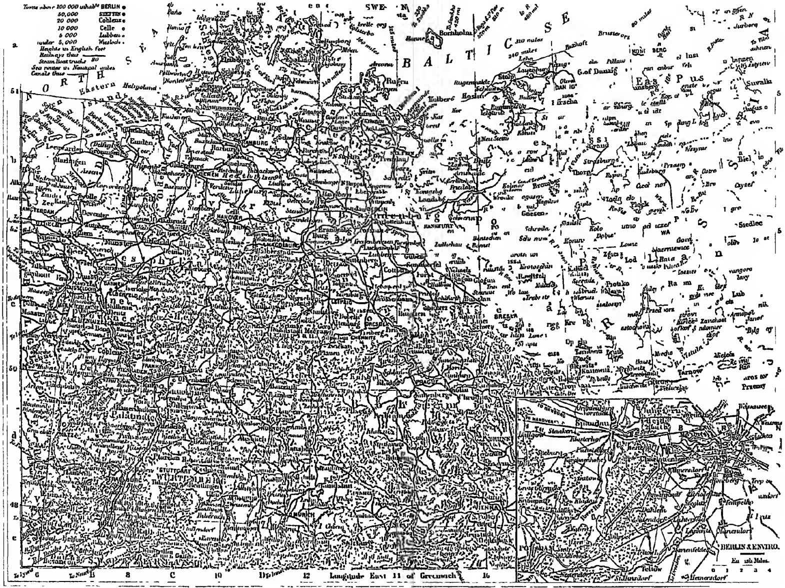
ELOCUTION.—III.

[*Continued from p.* 175.]

PUNCTUATION (*continued*).

VIII. THE DASH.

48. *A Dash is a short straight line which occurs in reading, and which is placed between the sentences in such a manner as to be parallel to the top of the page.*



English Miles

Natural Scale 1 : 3,330,000

London: Cassell & Company, Limited

Geographical or Nautical Miles

49. The dash is sometimes used to express a sudden stop, or change in the subject.

50. The dash requires sometimes a pause as short as that of a comma: and sometimes one as long as, if not longer than, that of a period.

51. The dash is frequently used instead of crotchets or brackets, and a parenthesis is thus placed between two dashes.

52. The dash is sometimes used to precede something unexpected; as when a sentence beginning seriously ends humorously.

53. In the following examples, the dash is used to express a sudden stop, or change of the subject.

Examples.

If you will give me your attention, I will show you—but stop, I do not know that you wish to see.

Alas! that folly and falsehood should be so hard to grapple with—but he that hopes to make mankind the wiser for his labours must not be soon tired.

"Please your honours," quoth Trim, "the Inquisition is the vilest—" "Prithee, spare thy description, Trim; I hate the very name of it," said my father.

The fierce wolf prowls around thee—there he stands listening—not fearful, for he nothing fears.

The wild stag hears the falling waters' sound, and tremblingly flies forward—o'er his back he bends his stately horns—the noiseless ground his hurried feet impress not—and his track is lost amidst the tumult of the breeze, and the leaves falling from the rustling trees.

54. The dash is sometimes to be read as a period, with the falling inflection of the voice.

Examples.

The favoured child of Nature, who combines in herself these united perfections, may justly be considered as the masterpiece of creation—as the most perfect image of the Divinity here below.

He had stopped soon after beginning the tale—he had laid the fragment away among his papers, and had never looked at it again.

The exaltation of his soul left him—he sank down—and his misery went over him like a flood.

Mr. Playfair was too indulgent, in truth, and favourable to his friends—and made a kind of liberal allowance for the faults of all mankind—except only faults of baseness or of cruelty; against which he never failed to manifest the most open scorn and detestation.

Towards women he had the most chivalrous feelings of regard and attention, and was, beyond almost all men, acceptable and agreeable in their society—though without the least levity or pretension unbecoming his age or condition.

55. The dash is sometimes to be read like a comma, with the voice suspended.

Examples.

"I have always felt that I could meet death with composure; but I did not know," she said, with a tremulous voice, her lips quivering—"I did not know how hard a thing it would be to leave my children, till now that the hour is come."

And Babylon shall become—she that was the beauty of kingdoms, the glory of the pride of the Chaldeans—as the overthrow of Sodom and Gomorrah by the hand of God.

Our land—the first garden of liberty's tree—it has been, and shall yet be, the land of the free.

They shall find that the name which they have dared to proscribe—that the name of MacGregor is a spell.

Delightful in his manners—inflexible in his principles—and generous in his affections, he had all that could charm in society, or attach in private.

She made an effort to put on something like mourning for her son; and nothing could be more touching than this struggle between pious affection and utter poverty; a black ribbon or so—a faded black handkerchief, and one or two more such humble attempts to express by outward signs that grief that passeth show.

56. The dash sometimes precedes something unexpected; as when a sentence beginning seriously ends humorously.

Examples.

Good people all, with one accord,
  Lament for Madame Blaize,
Who never wanted a good word—
  From those who spoke her praise.

The needy seldom passed her door,
  And always found her kind;
She freely lent to all the poor—
  Who left a pledge behind.

She strove the neighbourhood to please
  With manner wondrous winning;
And never followed wicked ways—
  Unless when she was sinning.

At church, in silks and satins new,
  With hoop of monstrous size;
She never slumbered in her pew—
  But when she shut her eyes.

Her love was sought, I do aver,
  By twenty beaux and more;
The king himself has followed her—
  When she has walked before.

But now her wealth and finery fled,
  Her hangers-on cut short all;
Her doctors found, when she was dead—
  Her last disorder mortal.

Let us lament, in sorrow sore,
  For Kent Street well may say
That had she lived a twelvemonth more—
  She had not died to-day

57. The dash is sometimes used with other pauses to lengthen them.

Examples.

In every pursuit, whatever gives strength and energy to the mind of man, experience teaches to be favourable to the interests of piety, of knowledge, and of virtue;—in every pursuit, on the contrary, whatever enfeebles or limits the powers of the mind, the same experience ever shows to be hostile to the best interests of human nature.

From the first hour of existence to the last,—from the cradle of the infant, beside which the mother watches with unslumbering eye, to the grave of the aged, where the son pours his bitterest tears upon the bier of his father,—in all that intermediate time, every day calls for exertion and activity, and moral honours can only be won by the steadfast magnanimity of pious duty.

They say they have bought it.—Bought it! Yes;—of

whom?—*Of* the poor trembling natives, who knew that refusal would be vain; and who strove to make a merit of necessity, by seeming to yield with grace, what they knew they had not the power to retain.

It is not the lifeless mass of matter, he will then feel, that he is examining,—it is the mighty machine of Eternal Wisdom: the workmanship of Him, in whom everything lives, and moves, and has its being.

When suffering the inconveniences of the ruder parts of the year, we may be tempted to wonder why this rotation is necessary;—why we could not be constantly gratified with vernal bloom and fragrance, or summer beauty and profusion.

Then a spirit passed before my face; the hair of my flesh stood up: it stood still, but I could not discern the form thereof: an image was before mine eyes:—There was silence, and I heard a voice—Shall mortal man be more just than God?

58. The dash is sometimes to be read like a note of interrogation.

Examples.

Is it not enough to see our friends die, and part with them for the remainder of our days—to reflect that we shall hear their voices no more, and that they will never look on us again—to see that turning to corruption, which was but just now alive, and eloquent, and beautiful with all the sensations of the soul?

He hears the ravens cry; and shall He not hear, and will He not avenge, the wrongs that His nobler animals suffer—wrongs that cry out against man from youth to age, in the city and in the field, by the way, and by the fireside?

Can we view their bloody edicts against us—their hanging, heading, hounding, and hunting down an ancient and honourable name—as deserving better treatment than that which enemies give to enemies?

Was there ever a bolder captain of a more valiant band? Was there ever—but I scorn to boast.

And what if thou shall fall unnoticed by the living—and no friend take note of thy departure?

59. The dash is sometimes to be read like a note of exclamation.

Examples.

The chain of being is complete in me; in me is matter's last gradation lost, and the next step is spirit—Deity! I can command the lightning, and am dust!

Above me are the Alps, the palaces of Nature, whose vast walls have pinnacled in clouds their snowy scalps, and throned Eternity in icy halls of cold sublimity, where forms and falls the avalanche—the thunderbolt of snow!

How has expectation darkened into anxiety—anxiety into dread—and dread into despair! Alas! not one memento shall ever return for love to cherish. All that shall ever be known is, that she sailed from her port, and was never heard of more.

A measure of corn would hardly suffice me fine flour enough for a month's provisions, and this arises to about six score bushels; and many hogsheads of wine and other liquids have passed through this body of mine—this wretched strainer of meat and drink! And what have I done all this time for God and man? What a vast profusion of good things upon a useless life and a worthless liver!

IX. THE HYPHEN.

60. *The Hyphen is a mark resembling a dash, but not so long.*

61. The hyphen is used to separate the syllables of a word; or to make one word of two: as, semicircle, sea-water.

62. When there is not room enough in the line for the whole of a word, some of its syllables are put into the line with a hyphen, and the remainder are put into the next line.

63. When a hyphen is placed over the vowels, it shows that they have their long sound.

Examples.

Extrāneous, sea-water, semi-circle, demi-gods, plane-trees, bed-side, over-canopied, toil-hardened, grey-haired, to-morrow, Sabbath-day, Sardanapālus, ill-requited, thunder-cloud, Europēan, Epicurēan, pine-covered, clay-cold, snow-clad, parish-clerk, night-steed, moon-eyed, āzure, all-wise, ēdict, fellow-creatures, icy, well-founded, ōmega, fellow-feeling, ūniform, prophesy, earth-born, far-wandering, storm-clouds, hymenēal, chāmber, fāiry, lēver, āpiary, cūlinary.

X. THE ELLIPSIS.

64. *Ellipsis means the omission of some word or words. Sometimes a sentence is unfinished, or some parts of it are purposely omitted; and the mark which indicates an ellipsis is put in the place of that which is left out.*

65. An ellipsis is sometimes indicated by a long straight line, thus, ————, which resembles a lengthened dash.

66. Sometimes the ellipsis is denoted by asterisks, or stars, thus, * * * * * *

67. Sometimes the ellipsis is marked by small dots, or periods, thus, ...

68. Sometimes the ellipsis is indicated by hyphens, thus, - - - - - - -

69. The ellipsis sometimes so closely resembles a dash in its effects, that it is scarcely distinguishable from it.

70. The voice is generally suspended at an ellipsis; but the falling inflection is frequently used when the ellipsis follows a question or explanation. In some of the following examples the dash and ellipsis are both used.

Examples.

Hast thou———— But how shall I ask a question which must bring tears into many eyes!

The air breathes invitation; easy is the walk to the lake's margin, where a boat lies moored beneath her sheltering tree.—
* * * * * * * * *

Forth we went, and down the valley, on the streamlet's bank, pursued our way, a broken company, mute or conversing, single or in pairs.

It is in vain to explain—the time it would take to reveal to you ———————— Satisfy my curiosity in writing them.

Indeed he is very ill, sir, ———— Can't help it. ———— We are very distressed, ———— Can't help it. ———— Our poor children, too, ———— Can't help that, neither.

Now, if he had married a woman with money, you know, why, then . . . . The suppliant turned pale, and would have fainted.

I have been, my dear S. . . . . on an excursion through the counties which lie along the eastern side of the Blue Ridge.

You have my answer: * * * —let my actions speak.

No, no, Dionysius; remember that it was I alone who displeased thee: Damon could not ———

If *he* were all ——— Remember haughty Henry, the nephew of his wife, whose word could speed a veteran army to his kinsman's aid.

I would not wound thee, Douglas, well thou knowest; but thus to hazard on a desperate cast thy golden fortunes ———

Still must I wonder; for so dark a cloud ——— Oh, deeper than thou think'st I've read thy heart.

Your grace will pardon me for obeying ——— Say *no* more, my child; you are yet too raw to make proper distinctions.

Let them - - - - - - or suppose I address myself to some particular sufferer—there is something more confidential in that manner of communicating one's ideas—as Moore says, Heart speaks to heart—I say, then, take especial care to write by candle-light.

That spares manual labour—*this* would relieve from mental drudgery, and thousands yet unborn - - - - - - - But hold! I am not so sure that the female sex in general may quite enter into my views on the subject.

XI. THE APOSTROPHE.

71. *The Apostrophe is a mark which differs from the comma in its being placed above the line, and in being used for a different purpose.*

72. The apostrophe shows that some letter or letters are left out; as *'tis* for *it is*, *tho'* for *though*, *lov'd* for *loved*.

73. The apostrophe is likewise used in grammar to designate the possessive case; as, John's book.

XII. THE QUOTATION MARK.
" "

74. *A Quotation mark consists of four commas placed above the line; two at the beginning and two at the end of a word, sentence, or part of a sentence. The two which are placed at the beginning are inverted, or turned upside down.*

75. A quotation mark shows that the word or sentence was spoken by someone, or was taken from some other author.

XIII. THE DIÆRESIS.

76. *A Diæresis consists of two periods placed over a vowel, thus, ä.*

77. The diæresis shows that the letter over which it is placed is to be pronounced separately; as, Creätor, Zoönomia, aërial.

In the following examples the student will recognise each of the above-mentioned marks, and read them accordingly.

Examples.

The kindling flies o'er heaven so bright, look sweetly out from yon azure sea.

A celebrated modern writer says, "Take care of the minutes, and the hours will take care of themselves." This is an admirable remark, and might be very seasonably recollected when we begin to be "weary in well-doing," from the thought of having much to do.

But thou, who Heaven's just vengeance dar'st defy, this deed, with fruitless tears, shall soon deplore.

For as I passed by, and beheld your devotions, I found an altar with this inscription, "To the Unknown God." Whom therefore ye ignorantly worship, Him declare I unto you.

XIV. THE ASTERISK, OBELISK, DOUBLE OBELISK, SECTION, PARALLEL, PARAGRAPH, INDEX, CARET, BREVE, AND BRACE.

The student should take particular notice of the following marks, so that he may call them by name, and discover their use in the following examples:—

* An Asterisk or Star.	¶ A Paragraph.
† An Obelisk or Dagger.	§ A Section.
‡ A Double Obelisk.	‖ A Parallel.

78. *The Asterisk, Obelisk, Double Obelisk, Paragraph, Section, Parallels, and sometimes figures or letters, are used to show that there is a note at the bottom of the page. When many notes occur on a page, these marks are sometimes doubled.*

79. The Paragraph was formerly used to show the beginning of a new subject in a chapter.

80. The Section is generally used to subdivide chapters into lesser parts.

81. The Index or Hand ☞ points to something which requires particular attention.

82. The Breve ˘ is placed over a letter to show that it has a short sound; as, Hĕlĕna.

83. The Brace ⏟ is used to unite several lines of poetry; or, in prose, to connect a number of words with one common term.

84. The Caret ‸ is never used in printed books; but in writing it shows that something has accidentally been left out; as,

recited
George has ‸ his lesson.

Obs.—When several asterisks or stars are placed together, they represent an ellipsis.

Examples.

Many persons pronounce the word Helĕna* incorrectly. They call it Helēna; and the words accept'able, rec'ognise, Epicure'an, and Europe'an, are sometimes incorrectly called ac'ceptable, recog'nise, Epicu'rean, and Euro'pean.

The lĕprosy, therefore, of Naáman shall cleave unto thee. * * * * And he went out from his presence a lĕper as white as snow.

The Cougar† is the largest animal, of the cat kind, found in North America; and has occasionally received the name of the American lion, from the similarity of its proportions and colour to those of the lion of the old world.

The keeper of the elephant gave him a gallon of arrack,‡ which rendered the animal very furious.

I fell upon my knees upon the bank, with my two servants, and the dragoman§ of the mōnăstĕry.

The history of Joseph is exceedingly interesting and full of instruction.‖

It was a cave, a huge recess, that keeps till June December's snow; a lofty precipice in front, a silent tarn¶ below.

$$\left.\begin{array}{l}\text{C-e-o-u-s,}\\ \text{C-i-o-u-s,}\\ \text{S-c-i-o-u-s,}\\ \text{T-i-o-u-s,}\end{array}\right\}\ \text{are pronounced like shus}$$

See where the rector's** splendid mansion stands, embossed deep in new enclosed lands—lands wrested from the indigent and poor, because, forsooth, he holds the village cure.††

When the young blood danced jocund through his veins 'tis said his sacred stole‡‡ received some stains.

Their wants are promised Bridewell, or the stocks.

BOTANY.—XVIII.

[Continued from p. 155.]

GAMOPETALÆ (continued).

THE series *Hypogynæ* (to the leading character of which there is only one prominent exception, the cranberry tribe) contains seven cohorts —the *Ericales*, *Primulales*, *Ebenales*, *Gentianales*, *Polemoniales*, *Personales*, and *Lamiales*. Of these the five first - named have usually polysymmetric flowers, the two last, monosymmetric ones; whilst the four last are sometimes grouped from a common characteristic as the *Bicarpellatæ*.

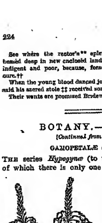


Fig 81.—ERICA HERBACEA (*A Heath*).

The *Ericales* have their flowers either tetramerous or pentamerous and diplostemonous; their anthers opening by pores, their ovaries multilocular, with large central placentas projecting into the loculi from the axis, and generally bearing numerous minute seeds The cohort includes the orders *Vacciniaceæ*, *Ericaceæ*, *Monotropaceæ*, and *Epacridaceæ*.

The *Vacciniaceæ*, the cranberries, bilberries, and whortleberries, are more or less woody plants, with small leaves and urceolate flowers, inhabiting hilly regions, mostly in the northern hemisphere. The floral formula is $(5)(5).5+5.(5)$, so that they form a connecting link with the series *Inferæ* in having an inferior ovary. The anthers open by pores, and the fruit is an edible berry.

The *Ericaceæ*, or heaths, are also mostly woody plants, and in many of them the exstipulate leaves are coriaceous, evergreen, entire, and of small size. The flowers are often tetramerous, the corolla is hypogynous, and the fruit, a capsule. They are dispersed over all the globe, and are especially abundant in the cold regions of the northern hemisphere, and at the Cape of Good Hope. Some species are gregarious, covering immense tracts in western and central Europe, where their presence indicates the soil to be unadapted to the culture of cereals. A great number of species belong to the Mediterranean region. The more shrubby forms, such as *Rhododendron*, *Azalea*, and *Kalmia* (Fig. 82) are known to gardeners as "American plants." Some Indian rhododendrons are epiphytic, and some species of *Pyrola* are brown parasites. The foliage is often astringent, and the honey of the flowers sometimes narcotic. The intoxicating honey of the Euxine—so celebrated amongst the ancients from the date of the retreat of the Ten Thoosand under the Greek historian Xenophon—derived its qualities from the flowers of *Azalea pontica* and *Rhododendron ponticum*.

The *Monotropaceæ* are a small group of brown parasites, with their foliage replaced by scales, growing upon the roots of trees. They are closely related to *Pyrola*. Similarly, the *Epacridaceæ* resemble the genos *Erica*; the true heaths, of which they may be said to be the Australian representatives, *Erica* not occurring in that continent, in Asia, or in America. *Epacris* has unilocular anthers.

The cohort *Primulales* is characterised by its generally pentamerous and isostemonous flowers, the five stamens being formed before the petals, and the latter being opposite to the stamens, and by its axial or free-central placentation. The petals have been described as outgrowths from the stamens. They spring, however, from the receptacular tube immediately outside the ring of stamens, and are subsequently carried up with them by intercalary growth. The cohort includes the orders *Plumbaginaceæ* and *Primulaceæ*, in both of which the typical floral formula is $(5).[(5).|5.](5)$.

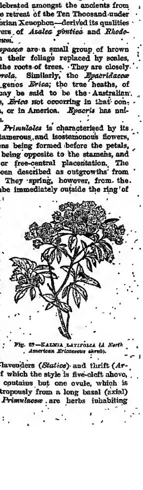


Fig. 82.—KALMIA LATIFOLIA (*A North American Ericaceous shrub*).

The *Plumbaginaceæ* include the bright flowered *Plumbago*, sea-lavenders (*Statice*) and thrift (*Armeria*), in all of which the style is five-cleft above, and the ovary contains but one ovule, which is suspended anatropously from a long basal (axial) funicle. The *Primulaceæ* are herbs inhabiting

alpine regions, salt-marshes, and other situations in the colder parts of the northern hemisphere. They have an undivided style and capitate stigma,

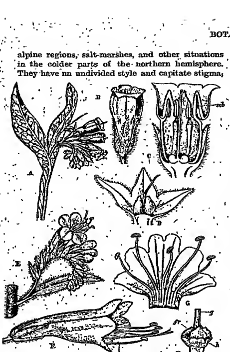


Fig. 83.—BORAGINACEÆ.
A, Comfrey, *Symphytum officinale*. B, Flower of the same. C, Longitudinal section; *sch*, throat scale. D, Calyx and fruit, in section. E, Viper's Bugloss, *Echium vulgare*, one branch of inflorescence. F, Flower. G, Corolla and stamens displayed. H, Gynæceum; *fr*, ovary; *g*, base of style; *h*, honey-glands.

and the placenta is "free central," generally globular and bearing many ovules, each having two coats, an unusual character among *Gamopetalæ*. The leaves are often radical, or sometimes opposite. The fruit is a capsule, dehiscing by teeth in *Primula*, transversely in the pimpernel (*Anagallis*). Many species of *Primula* are dimorphously heterogonous (*see* Vol. IV., p. 186), and this and other groups furnish many pretty alpine plants to our gardens. In the common primrose (*Primula vulgaris*) we have a præmorse rhizome and an umbellate inflorescence, the peduncle of which is normally very short, whilst the pedicels are long. In the cowslip (*P. veris*) the peduncle is long, the pedicels short.

The *Ebenales* include several orders, mainly of tropical trees, having ovaries with two or more loculi each containing usually one or two ovules, forming a baccate fruit, and having often more than five stamens. The *Sapotaceæ* include the genera *Isonandra*, *Dichopsis*, *Palaquium*, etc., from the latex of which gutta-percha is obtained; *Bassia latifolia*, the mahwa of India, with edible oleaginous and saccharine petals; and other species of this genus with fatty fruits. The *Ebenaceæ* includes the genus *Diospyros*, with a dense black or brown heartwood, known as ebony, and in some species edible fruits, the persimons of the United States.

Gentianales, the first of the four bicarpellate cohorts, includes several considerable orders, which mostly agree in having opposite and decussate leaves, a polysymmetric corolla and isomerous stamens, which are epipetalous. The *Oleaceæ*, or olive family, are a small group of trees and shrubs chiefly inhabiting temperate regions, with either simple or pinnate leaves and generally dimerous flowers, the typical formula being (2+2).[(4).2.](2). Their fruits vary considerably, but the seeds are always albuminous. In the olive (*Olea europæa*), a native of southern Europe, the fruit is drupaceous, having a stony endocarp and oily mesocarp, yielding one of the most valuable of oils. In the common ash (*Fraxinus excelsior*), a British tree yielding timber

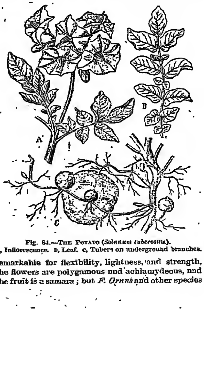


Fig. 84.—THE POTATO (*Solanum tuberosum*).
A, Inflorescence. B, Leaf. C, Tubers on underground branches.

remarkable for flexibility, lightness, and strength, the flowers are polygamous and achlamydeous, and the fruit is a samara; but *F. Ornus* and other species

in southern Europe, which yield the sugary excretion called manna, have both calyx and corolla, the latter being white and deeply divided. The privet (*Ligustrum vulgare*) bears black nuculanes; and the lilac (*Syringa vulgaris*), a native of Persia, loculicidal capsules. The jasmines (*Jasminum*) are mostly Asiatic climbing shrubs, ranked by some botanists as a distinct order, since they have generally five sepals and five petals, though only two stamens, and the petals are imbricate instead of being valvate as are those of other *Oleaceæ*. They are valued for their fragrance. The *Apocynaceæ* are a large group, mainly tropical, but represented in Britain by the periwinkle (*Vinca*). They have generally a very poisonous latex; but india-rubber is obtained from it in *Vahea*, *Willughbeia*, *Hancornia*, *Urceola*, *Dyera*, *Landolphia*, and other genera. The oleander (*Nerium*), *Allamanda*, and others, are stove-plants with large showy flowers. The convolute æstivation of the corolla and the dumbbell-shaped stigma, both well seen in *Vinca*, are characteristic. The *Asclepiadaceæ* are another large tropical group, closely related to the *Apocynaceæ*, but remarkable in the construction of their stamens and stigmas, the pollen remaining coherent in *pollinia*, or groups of grains. *Stapelia* is a genus of fleshy, cactus-like, leafless plants, characteristic of South Africa, with fetid, lurid flowers. The *Loganiaceæ*, another considerable tropical group, are chiefly of interest as including the genus *Strychnos*, various species of which, especially *S. Nux-vomica*, yield the powerfully poisonous alkaloid strychnia. The ourare poison of Guiana is obtained from the same genus. The *Gentianaceæ*, which give their name to the cohort, are a large and widely diffused order of glabrous herbs, with a bitter, tonic juice; opposite, sessile, and mostly simple, entire, exstipulate leaves, with a prominent mid-rib; a dichasial inflorescence; a unilocular ovary, with two parietal placentas; and numerous small albuminous seeds in the septicidal capsule. The placentation is a distinctive character separating them from several allied orders. The brilliant blue flowers of the large genus *Gentiana*, among the most beautiful of alpine plants, are seen on mountains within the tropics, but not in polar regions. The pink centaury (*Erythræa Centaurium*), the perfoliate yellow-wort (*Blackstonia perfoliata*), and the bog-bean (*Menyanthes trifoliata*), with its beautifully fringed white petals, are familiar British plants.

The cohort *Polemoniales*, differing from the last mainly in having scattered leaves, exserted stamens, central placentation, and fewer seeds, contains—besides the small order *Polemoniaceæ*, from which it takes its name, which is closely related to *Convolvulaceæ*, and contains the Greek valerian, or Jacob's ladder (*Polemonium cæruleum*), and the climbing *Cobæa*—the three large orders, *Convolvulaceæ*, *Boraginaceæ*, and *Solanaceæ*.

The *Convolvulaceæ* derive their name from the property which most, although not all of them, have of climbing up other plants. They abound in the torrid zone, in low marshy situations, especially near the sea. In proportion as the distance from the equator diminishes, so do the *Convolvulaceæ* become more rare. In temperate climates only few species exist; and in the frigid zone they are altogether absent. The five sepals are imbricate, whilst the five corolla-lobes are convolute or contorted in æstivation. The two-chambered ovary is sometimes rendered four-chambered by the ingrowth of the midribs of the carpellary leaves. Plants of this order generally contain some milky latex, and are purgative. Jalap is the root of the Mexican *Exogonium Purga*; but the tubers of *Ipomœa edulis* are the edible sweet potato. *Pharbitis purpurea* and *Convolvulus tricolor* are the two most commonly cultivated species. *Cuscuta*, the dodders, is a genus of troublesome parasites, attacking flax, clover, and other crops. They have tangled, thread-like red stems, with only minute scale-leaves, and bearing clusters of small waxlike flowers. Their seeds contain an embryo, consisting only of an axis with barely perceptible cotyledons coiled round the albumen. This embryo germinates in the ground; but when the stem has attached itself to a host plant by the rootlike suckers (*haustoria*), with which it penetrates to the cambium, the connection with the ground withers.

The *Boraginaceæ* (Fig. 83) were called by Linnæus *Asperifoliæ*, owing to their generally rough surfaces. They are a large order of herbs, mostly natives of the north temperate zone, with scattered, simple, entire, and not aromatic leaves; a "scorpioid" inflorescence, apparently really racemose; an ovary of two carpels, so divided by the ingrowth of the midrib as to form four indehiscent, one-seeded "nutlets" or cocci; a gynobasic style, and exalbuminous seeds. Borage (*Borago officinalis*) and other species contain a good deal of potassium nitrate, for which reason the former is used in "cool tankards." The dye alkanet is obtained from the root of *Anchusa tinctoria* and prickly comfrey (*Symphytum peregrinum*) is grown as horse-forage. *Myosotis palustris* is the "forget-me-not." Heliotrope (*Heliotropium peruvianum*) belongs to a small closely related group.

The *Solanaceæ* are a large, generally distributed order of herbaceous, or rarely arborescent plants, with colourless juice, scattered leaves, a cymose inflorescence of pentamerous flowers which are

generally polysymmetric, a calyx generally persistent, and a capsule or nuculane usually of two carpels with numerous albuminous seeds. The floral formula is (5). [(5) 5.] (2), the odd sepal being posterior, and the æstivation of the corolla, which varies considerably in form, being plicate. Though yielding several valuable articles of food, the order is a very dangerous one, containing as it does many plants which are powerful narcotic poisons. *Atropa Belladonna*, the deadly nightshade, a shrubby plant not uncommon on our limestone hills, has a lurid brownish-purple campanulate corolla, and a black nuculane often fatally mistaken by children for a cherry, but with a persistent calyx. The alkaloid atropine, which is contained in the fruit, seeds, and foliage, has the property of relaxing the iris and thus dilating the pupil of the eye, and the plant has accordingly been used in ophthalmic medicine and by ladies to add to their attractions, whence the specific name *Belladonna*, "beautiful lady." The allied *Duboisia Hopwoodii*, the pituri, used as a stimulant by the Australian natives, produces the same effect. *Datura Stramonium*, the thorn-apple, has a thorny loculicidal and septifragal capsule, four-chambered from the ingrowth of the midribs of the carpels. It contains the narcotic alkaloid daturine, similar in action to atropine and duboisine, but useful in small doses as an antispasmodic, its leaves being smoked by asthmatic subjects. *Hyoscyamus niger*, the henbane, which has a transversely dehiscing capsule, contains a similar alkaloid *hyoscyamine*.

The mandrake (*Mandragora officinalis*) is nearly allied to the Belladonna. It grows in the south of Europe, and in dark places, and has been known and celebrated from times of very great antiquity, being employed by the sorcerers of ancient times to produce narcotism and disordered visions. Its roots are large, often two-pronged, whence the fancied resemblance to the lower limbs of a man.

Nicotiana Tabacum, apparently a native of the West Indies, is the species to which most cultivated tobacco belongs. *N. affinis* and other species are grown for their beautiful and sweet-scented flowers; and the *Petunia* is closely allied to the tobacco plant, its name being derived from *petun*, the Brazilian name for tobacco.

Physalis, the winter cherry or Cape gooseberry, has a round edible nuculane enclosed in an accrescent calyx which becomes of the same scarlet colour as the fruit. This colour is common in the fruits of the order, as in those of the now much eaten West Indian tomato, *Lycopersicum esculentum*, and the pungent capsicum and Chili peppers (*Capsicum annuum* and *C. fastigiatum*), originally East Indian. Cayenne pepper is the powdered fruit of *C. frutescens* and other species. The large genus *Solanum*, which gives its name to the order, has syngenesious anthers, and includes the common bittersweet or woody night-shade of our hedgerows (*S. Dulcamara*), the brinjal, aubergine, or egg-plant (*S. Melongena* and *S. oviferum*), with large edible fruits, and, most important of all, the potatoes. Several species of the genus bear tubers, *S. tuberosum*, the potato (Fig. 81) being apparently originally a native of dry regions of the Chilian and Peruvian Andes, and therefore peculiarly liable to disease in our more humid climate; whilst the recently introduced *S. Maglia* comes from a less dry region and promises to prove valuable. The chief disease affecting the potato is a fungoid mould, *Phytophthora infestans*.

Structurally the order *Solanaceæ* passes by almost insensible gradations into the *Scrophulariaceæ*, though this latter order is, owing to its usually monosymmetric flowers, referred to another cohort, the *Personales*. To the same group belong the less important orders, *Orobanchaceæ*, *Lentibulariaceæ*, *Gesneraceæ*, *Bignoniaceæ*, and *Acanthaceæ*. These agree in having pentamerous flowers symmetrical to the median plane, epipetalous stamens, of which the posterior one is usually abortive or suppressed, and the remaining four are often didynamous, and two carpels in the median plane, forming a capsule with indefinite seeds.

The *Scrophulariaceæ* are mostly herbs, and are most numerous in temperate climates. Their leaves are simple and exstipulate, but may be either scattered or whorled. They have a persistent calyx, a corolla which may be spurred, personate, or sub-rotate, a terminal style, two-chambered ovary, central placentas, and albuminous seeds. The typical formula may be said to be ↓(5) [(5) 4.](2). Many genera in the order are root-parasites with relatively small leaves, such as *Rhinanthus*, the yellow rattle; *Melampyrum*, the cow-wheat; *Pedicularis*, red rattle; *Bartsia* and *Euphrasia*, eyebright. Few groups contain a larger proportion of showy flowers, among which the foxglove (*Digitalis purpurea*), snapdragon (*Antirrhinum majus*), *Calceolaria*, *Mimulus*, and *Veronica* are the most familiar. They vary in their medicinal properties, the most important being *Digitalis*, the alkaloid of which, *digitaline*, diminishes the action of the heart. *Pentstemon* has five stamens; *Verbascum*, the mullein, has five, but with one generally aborted; and, whilst most plants of the order are didynamous, *Veronica* has only two stamens, the posterior pair. In this genus also the two posterior petals are so united as to appear like one broad one, the corolla being sub-rotate.

The *Orobanchaceæ*, or broom-rapes, are brown fleshy root-parasites, with no chlorophyll, and their

foliage represented only by leaf-scales. Their flowers differ from those of *Scrophulariaceæ* mainly in having a one-chambered ovary with parietal placentas. *Orobanche minor* is destructive to clover.

The *Lentibulariaceæ* are an interesting group of marsh and aquatic plants, deriving their nitrogenous food from captured animals. They have a bilabiate calyx, a personate or bilabiate and spurred corolla, only the two anterior stamens, and a one-chambered ovary with free-central placentation and exalbuminous seeds. *Utricularia*, the bladder-wort, has no roots in its adult state, but has its finely divided submerged leaves furnished with remarkable bladders or utricles. These have a trap-door, or operculum, opening inwards only, and capture water-fleas which decay and are absorbed, as a sort of liquid manure, by numerous four-rayed hairs in the interior of the bladder. *Pinguicula*, the butter-wort, has a rosette of oval radical leaves studded with remarkably formed glands, and exuding a viscid substance. The edges of the leaves roll involutely over flies captured by this stickiness, the secretion becomes acid, and a true digestion takes place. Milk placed on the leaves is curdled, and a few drops, if left, will be digested.

The *Gesneraceæ* are a tropical group, often epiphytic, with showy flowers, some of which, such as *Achimenes* and *Gloxinia*, are familiar hot-house plants. The *Bignoniaceæ* derive their name from the genus *Bignonia*, or trumpet-flower, dedicated to the Abbé Bignon, librarian to Louis XIV., a great promoter of botany. They are generally woody plants, often climbing lianes in the tropical forests of America; their wood is divided into 4, 8, or 16 segments by wedge-like processes of the bark; their flowers are large and trumpet-shaped, and their seeds furnished with a broad paper-like wing. The greater number of the *Acanthaceæ* are natives of the tropics, but a few are indigenous to Italy, Greece, and other Mediterranean regions. The picturesque beauty of the leaves of *Acanthus mollis* arrested the attention of the painters, sculptors, and architects of antiquity. The capitals surmounting the columns of the Corinthian order are formed on the general basis of an acanthus leaf.

FRENCH.—XXVIII.

[Continued from p. 166.]

THE SUBJUNCTIVE.

THE subjunctive is the mode of doubt:—

Obeis si tu veux qu'on t'obéisse un jour. VOLTAIRE.	*Obey, if thou wishest that one day others may obey thee*

The use of the subjunctive is not wholly and solely a matter of grammar: the same verb, used in the same manner, may, or may not, be followed by the subjunctive, according as the speaker wishes to express or not to express doubt:—

Je ne *pense* pas qu'il *vienne*.	*I do not think he will come.*
Je ne *pense* pas qu'il *vient*.	*I do not think he is coming.*

When the principal clause of the sentence is interrogative or negative, and expresses doubt, the verb of the subordinate clause is put in the subjunctive:—

Pensez-vous que vous *réussissiez* dans cette affaire?	*Do you think that you will succeed in this affair?*
Je ne voudrais pas assurer qu'on le *doive* écrire. BOILEAU.	*I would not affirm that it should be written.*
Croyez-vous qu'il *vienne*?	*Do you believe he will come?*

Most verbs expressing *consent, command, doubt, desire, pleasure, grief, surprise, want, duty, exhortation, necessity, fear, apprehension*, require the subjunctive:—

Je *permets*, je *souhaite*, je *doute*, je *veux*, j'*ordonne*, je suis *surpris*, que vous *veniez*.	*I permit, I wish, I doubt, I desire, I order, I am surprised, that you may or should come.*
Dès ce même moment, ordonnez que je *parte*. RACINE.	*Order, that I may depart this very moment.*
Tu veux qu'en ta faveur nous *croyions* l'impossible. CORNEILLE.	*Thou wishest that for thy sake we may believe in impossibilities.*
Je suis *ravi* que nous *logions* ensemble. DESTOUCHES.	*I am delighted that we happen to live together.*

When the first verb expresses fear or apprehension, the verb in the subjunctive must be preceded by *ne*:—

Je crains, je tremble, j'appréhende, j'ai peur, qu'il *ne vienne*.	*I fear, I tremble, I apprehend, I am afraid he may come.*

The pronouns *qui, que, lequel, dont, où*, should be followed by the subjunctive, when that part of the sentence which precedes them expresses an interrogation, or implies a wish, a doubt, or a condition. They must also be followed by the verb in the subjunctive when they are preceded by a superlative, relative, or such adjectives as have the import of a superlative; as *seul, premier, dernier*, etc.:—

Y a-t-il quelqu'un *qui* ne *respecte* le malheur?	*Is there anyone who does not respect misfortune?*
La *meilleure* chose que vous *puissiez* faire.	*The best thing that you can do.*
Choisissez une retraite *où* vous *soyez* tranquille.	*Choose a retreat in which you may enjoy repose.*
C'est le *seul* que je *connaisse*.	*He is the only one I know.*

A verb preceded by one of the impersonal verbs *falloir, importer, convenir, suffire, valoir mieux*, or by the verb *être*, used impersonally in connection with the adjectives *fâcheux, juste, injuste, surprenant, possible*, or with *à propos, temps, à désirer, à souhaiter*, etc., must be put in the subjunctive:—

Il *faut* que vous *veniez*.	*You must come, or it is necessary that you should come.*
Il *est temps* que vous *partiez* pour Rome.	*It is time that you should start for Rome.*
Il ne me *plaît* pas que vous *alliez* là. L'ACADÉMIE.	*It does not please me that you should go there.*
Il *n'est* pas certain que vous *ayez* raison.	*It is not certain that you are right.*

After the expressions *quelque . . . que, quel que, si . . . que, quoi que*, the verb is always put in the subjunctive :—

Quelque effort *que fassent* les hommes, leur neant parait partout. BOSSUET.	*Whatever effort men may make, their nothingness appears everywhere.*
Qui que ce *soit*, parlez et ne le craignez pas. RACINE.	*Whoever he may be, speak, and do not fear him.*
Si mince *qu'il puisse* être, un cheveu fait de l'ombre. VILLEFRÉ.	*However thin it may be, a hair has a shadow.*

THE INFINITIVE.

The infinitive represents the being or doing in an indefinite manner, and without number or person :—

Vouloir tromper le ciel, c'est folie à la terre. LA FONTAINE.	*To wish to deceive heaven is folly in men.*
L'ardeur de *vaincre* cède à la peur de *mourir*. CORNEILLE.	*The ardour of conquest (to conquer) yields to the fear of death (to die).*
Hair est un tourment. SÉGUR.	*To hate is a torment.*

The infinitive is often used substantively :—

Ou plutôt, que ne puis-je au doux *tomber* du jour? LAMARTINE.	*Or rather, why can I not at the sweet close of the day?*

The infinitive present is used in French after certain verbs which are in English joined to other verbs by the conjunction *and* :—

Allez *chercher* mon père.	*Go and fetch my father.*

A verb immediately preceded by another verb (*avoir* and *être* excepted) is put in the present of the infinitive when both verbs have the same subject, or when the object of the first is the subject of the second. With the exception of *en*, prepositions require the present or the past of the infinitive :—

Tout ce qu'elle s'imaginait *tenir*, lui échappait tout-à-coup. FÉNELON.	*All that she fancied that she held, escaped her suddenly.*
Vos raisons sont trop bonnes d'elles-mêmes, *sans être* appuyées de ces secours étrangers. RACINE.	*Your reasons are too good in themselves to need that foreign assistance.*
Vous pensez tout *savoir*. PIEYRE.	*You think that you know everything.*
Je les vois *venir*.	*I see them coming.*
J'entends votre ami *chanter*.	*I hear your friend singing.*
Ils parlent *de partir*.	*They speak of going away.*
Après avoir dit cela, il s'assit.	*After having said that, he sat down.*

The French language, preferring the active to the passive voice, requires the use of the active verb in the following and similar cases wherein the English use the passive voice :—

Cette dame est bien *à plaindre*.	*That lady is much to be pitied.*
Cette maison est *à vendre*.	*This house is to be sold.*
La chose est de trop peu de conséquence pour la *traiter* sérieusement. VOLTAIRE.	*The matter is of too little consequence to be treated seriously.*

GOVERNMENT OF VERBS.

Some verbs are in English governed by prepositions different from those which connect or govern the same verbs in French. Some, again, which are in English joined by prepositions, require none between them in French. We give below lists of verbs with the appropriate prepositions, according to the best French authorities.

VERBS REQUIRING NO PREPOSITION BEFORE ANOTHER VERB IN THE INFINITIVE.

Accourir, *to run to.*
Aimer mieux, *to prefer.*
Aller, *to go.*
Apercevoir, *to perceive.*
Assurer, *to assure.*
Avouer, *to confess.*
Compter, *to intend.*
Confesser, *to confess.*
Courir, *to run.*
Croire, *to believe.*
Daigner, *to deign.*
Déclarer, *to declare.*
Désirer, *to desire.*
Devoir, *to be obliged.*
Écouter, *to hear, to listen.*
Entendre, *to hear.*
Envoyer, *to send.*
Espérer, *to hope.*
Faire, *to make.*
Falloir, *to be necessary.*
Imaginer (s'), *to imagine.*
Laisser, *to let, to suffer.*
Mener, *to take, to lead.*
Nier, *to deny.*
Observer, *to notice, to observe.*
Oser, *to dare.*
Paraitre, *to seem.*
Penser, *to think, to fancy.*
Pouvoir, *to be able.*
Préférer, *to prefer.*
Prétendre, *to pretend*, etc.
Rappeler (se), *to remember.*
Rapporter, *to report.*
Reconnaitre, *to acknowledge.*
Regarder, *to look at.*
Retourner, *to return.*
Revenir, *to come back.*
Savoir, *to know.*
Sembler, *to seem.*
Sentir, *to feel.*
Souhaiter, *to wish.*
Soutenir, *to maintain.*
Valoir mieux, *to be better*
Venir, *to come.*
Voir, *to see.*
Vouloir, *to be willing.*

Je prétends vous *traiter* comme mon propre fils. RACINE.	*I intend to treat you as my own son.*
Et le Rhin de ses flots *ira grossir* la Loire, Avant que tes faveurs sortent de ma mémoire. BOILEAU.	*And the Rhine will go and swell the Loire with its waves, before the remembrance of thy goodness leaves my memory.*

VERBS REQUIRING THE PREPOSITION *à* BEFORE AN INFINITIVE.

The (*s'*) placed after the verb shows it to be reflective.

Abaisser (s'), *to stoop.*
Aboutir, *to end in.*
Accorder (s'), *to agree.*
Accoutumer, *to accustom.*
Acharner (s'), *to strive.*
Admettre, *to admit, to permit.*
Aguerrir (s'), *to become inured.*
Aider, *to help.*
Aimer, *to like.*
Appliquer (s'), *to endeavour, to apply.*
Apprendre, *to learn.*
Apprêter (s'), *to prepare.*
Aspirer, *to aspire.*
Assigner, *to summon.*
Assujettir (s'), *to subject oneself.*
Attacher (s'), *to apply.*
Attendre (s'), *to expect.*
Autoriser, *to authorise.*
Avilir (s'), *to debase oneself.*
Avoir, *to have.*
Avoir peine, *to have difficulty in.*
Balancer, *to hesitate.*
Borner (se), *to confine oneself.*
Chercher, *to endeavour.*
Complaire (se), *to delight in.*
Concourir, *to co-operate.*
Condamner (se), *to condemn oneself.*
Condescendre, *to condescend.*
Consentir, *to consent.*
Consister, *to consist.*
Conspirer, *to conspire.*
Consumer, *to destroy.*
Contribuer, *to contribute.*
Convier, *to invite.*
Coûter, *to cost.*
Déterminer, *to induce.*
Déterminer (se), *to resolve.*
Disposer (se), *to prepare oneself.*
Divertir (se), *to amuse oneself.*
Employer, *to employ, to devote.*
Encourager, *to encourage.*
Engager, *to induce.*
Enhardir, *to embolden.*
Enseigner, *to teach.*
Entendre (s'), *to be expert in.*
Être, *to be.*
Evertuer (s'), *to strive.*
Exceller, *to excel.*
Exciter, *to excite.*
Exhorter, *to exhort.*
Exposer (s'), *to expose oneself.*
Fatiguer (se), *to weary oneself.*
Habituer (s'), *to become used to.*
Hasarder (se), *to venture.*
Hesiter, *to hesitate.*
Instruire, *to instruct.*
Intéresser, *to interest.*
Inviter, *to invite.*
Mettre, *to set, to put.*
Mettre (se), *to commence.*
Montrer, *to show, to teach.*
Obstiner (s'), *to persist in.*
Offrir (s'), *to offer.*

Pencher, *to incline.*
Penser, *to think, to intend.*
Persévérer, *to persevere.*
Persister, *to persist.*
Plaire (se), *to delight in.*
Pousser, *to urge.*
Prendre garde, *to heed, mind, take care.*
Prendre plaisir, *to take pleasure.*
Préparer (se), *to prepare.*
Porter } *to induce, to excite, to urge.*
Provoquer, }
Réduire, *to constrain.*
Réduire (se), *to tend, to end.*
Renoncer, *to renounce.*
Répugner, *to be repugnant.*
Résigner (se), *to be reconciled.*
Résoudre (se), *to resolve.*
Rester, *to tarry too long.*
Réussir, *to succeed.*
Risquer, *to risk.*
Servir, *to serve.*
Songer, *to think, to intend.*
Suffire (not imp.), *to suffice.*
Tarder, *to tarry.*
Tendre, *to tend.*
Tenir, *to intend, to aim.*
Travailler, *to labour.*
Viser, *to aim.*
Vouer, *to devote.*

L'homme n'aime point à s'occuper de son néant, et de sa bassesse. MASSILLON.	*Man does not like to contemplate his nothingness and his vileness.*
Avez vous jamais *pensé à* offrir à Dieu toutes ces souffrances? MASSILLON.	*Have you ever thought of offering all these sufferings to God?*

VERBS REQUIRING THE PREPOSITION *de* BEFORE AN INFINITIVE.

Abstenir (s'), *to abstain.*
Accuser (s'), *to accuse oneself.*
Achever, *to finish.*
Affecter, *to affect.*
Affliger (s'), *to grieve.*
Agir (s'), imp., *to be the question.*
Applaudir (s'), *to rejoice.*
Appréhender, *to apprehend.*
Avertir, *to warn.*
Aviser (s'), *to bethink oneself.*
Avoir besoin, *to want.*
Avoir coutume, *to be accustomed.*
Avoir dessein, *to intend.*
Avoir envie, *to wish.*
Avoir garde, *to take care.*
Avoir honte, *to be ashamed.*
Avoir intention, *to intend.*
Avoir le courage, *to have courage.*
Avoir le temps, *to have time.*
Avoir peur, *to be afraid.*
Avoir raison, *to be right.*
Avoir regret, *to regret.*
Avoir soin, *to take care.*
Avoir sujet, *to have reason.*
Avoir tort, *to be wrong.*
Blâmer, *to blame.*
Brûler, *to wish ardently.*
Cesser, *to cease.*
Chagriner (se), to *grieve oneself.*
Charger, *to desire, to intrust.*
Charger (se), *to take on oneself.*
Choisir, *to choose.*
Commander, *to command.*
Conjurer, *to beseech.*
Conseiller, *to advise.*
Contenter (se), *to be satisfied.*
Convaincre, *to convince.*
Convenir, *to become, suit.*
Corriger, *to correct.*
Craindre, *to fear*
Décourager, *to discourage.*
Dédaigner, *to disdain.*
Défendre, *to forbid.*
Défendre (se), *to defend oneself.*
Défier, *to challenge, to dare.*
Dépêcher (se), *to hasten.*
Désaccoutumer (se), } *to leave off.*
Déshabituer (se), }
Désespérer, *to despair.*
Désoler (se), *to grieve.*
Détourner, *to dissuade.*
Différer, *to put off.*
Dire, *to say, tell.*
Discontinuer, *to discontinue.*
Disconvenir, *to deny.*
Disculper (se), *to clear oneself.*
Dispenser, *to dispense.*
Dispenser (se), *to forbear.*
Dissuader, *to dissuade.*
Douter, *to doubt.*
Efforcer (s'), *to endeavour.*
Effrayer (s'), *to be frightened.*
Empêcher, *to prevent.*
Empresser (s'), *to hasten.*
Enrager, *to be vexed, enraged.*
Entreprendre, *to undertake.*
Épouvanter (s'), *to be frightened.*
Étonner (s'), *to wonder.*
Éviter, *to avoid.*
Excuser (s'), *to excuse oneself.*
Feindre, *to feign.*
Féliciter, *to congratulate.*
Flatter (se), *to flatter oneself.*
Frémir, *to shudder.*
Garder (se), *to take care not, beware.*
Gémir, *to lament.*
Glorifier (se), *to pride oneself.*
Hasarder (se), *to venture.*
Hâter (se), *to hasten.*
Imputer, *to impute.*
Indigner (s'), *to be indignant.*
Ingérer (s'), *to take into one's head.*
Inspirer, *to inspire.*
Jurer, *to swear.*
Manquer, *to fail.*
Méditer, *to think, to intend.*
Mêler (se), *to meddle.*
Menacer, *to threaten.*
Mériter, *to deserve.*
Moquer (se), *to laugh at.*
Mourir (figur.), *to long.*
Négliger, *to neglect.*
Nier, *to deny.*
Pardonner, *to excuse.*
Parler, *to speak.*
Passer (se), *to do without.*
Permettre, *to permit.*
Persuader, *to persuade.*
Piquer (se), *to take pride in.*
Plaindre, *to pity.*
Plaindre (se), *to complain.*
Prendre garde, *to take care not, beware.*
Prendre soin, *to take care.*
Prescrire, *to prescribe.*
Presser, *to urge.*
Presser (se), *to hasten.*
Présumer, *to presume.*
Prier, *to desire.*
Promettre, *to promise.*
Proposer, *to propose.*
Proposer (se), *to intend.*
Protester, *to protest.*
Punir, *to punish.*
Rebuter (se), *to be weary.*
Recommander, *to recommend.*
Refuser, *to refuse.*
Regretter, *to regret.*
Réjouir (se), *to rejoice.*
Remercier, *to thank.*
Repentir (se), *to repent.*
Reprendre, *to censure.*
Reprocher (se), *to reproach oneself.*
Résoudre, *to resolve.*
Ressouvenir (se), *to remember.*
Rire, *to laugh.*
Rougir, *to blush.*
Scandaliser (se), *to take offence.*
Seoir (imp.), *to become, suit.*
Sommer, *to summon.*
Soupçonner, *to suspect.*
Souvenir (se), *to remember.*
Suffire (imp.), *to suffice.*
Suggérer, *to suggest.*
Supplier, *to beseech.*
Témoigner, *to show.*
Tenter, *to attempt.*
Trembler, *to tremble.*
Vanter (se), *to boast.*

J'ai *intention de* voyager.	*I intend to travel.*
Mon frère *cessa de* parler.	*My brother ceased speaking.*
Il vaut mieux *hasarder de* sauver un coupable que *de condamner* un innocent. VOLTAIRE.	*It is better to run the risk of sparing a guilty person, than of condemning an innocent one.*
Le monde se *vante de* faire des heureux. MASSILLON.	*The world boasts that it can render men happy.*

RULE ON THE CONSTRUCTION OF VERBS REQUIRING DIFFERENT PREPOSITIONS.

Two or more verbs may govern the same object, provided they are all transitive, or require all the same preposition :—

Nous *aimons*, nous *instruisons*, et nous *louons* nos *enfants*.	*We love, we instruct, and we praise our children.*
Je *pense* et j'*écris* souvent *à* mes *amis*.	*I often think of and write to my friends.*

These sentences are correct, because *aimer, instruire*, and *louer*, being all transitive verbs, admit of a direct object; and *penser* and *écrire* require both the same preposition—viz., *à*.

But when the verbs require different kinds of objects, or different prepositions, they cannot govern one of the same noun ; and therefore another form must be given to the sentence. We could not say in French—Un grand nombre de vaisseaux entrent et sortent de ce port tous les mois, *A great number of vessels enter and go out of this port every month*, or J'aime et j'écris à mes enfants, *I love and write to my children*, because *entrer* requires the preposition *dans; sortir*, the preposition *de; aimer*, no preposition ; and *écrire*, the preposition *à*. We should say :—

Un grand nombre de vaisseaux entrent *dans* ce port et *en* sortent tous les mois	*A large number of vessels enter this port and leave it every month.*
J'aime mes *enfants*, et je *leur* écris.	*I love my children and write to them.*

THE PARTICIPLE PAST.

We have already seen that the participle past, not accompanied by an auxiliary, assumes the gender and number of the noun which it qualifies :

Les inimitiés sourdes et *cachées* sont plus à craindre que les haines *ouvertes* et *déclarées*. NOEL.	*Quiet and concealed enmity is more to be feared than open and declared hatred.*

The participle past, accompanied by the auxiliary *être*, agrees in gender and number with the

subject of the verb, whether the subject be placed before or after it, and whether the verb is passive or intransitive :—

Le fer est *émoussé*; les bûchers sont *éteints*. VOLTAIRE.	*The sword is blunted; the piles are extinguished.*
La vertu obscure est souvent *méprisée*. MASSILLON.	*Humble virtue is often despised.*
Ma mère est *sortie*.	*My mother is gone out.*
Mes tantes sont *arrivées*.	*My aunts have arrived.*
Leurs fils sont *devenus* grands.	*Their sons have become tall.*
Son grand-père est *mort* hier.	*His grandmother died yesterday.*
Quand il vit l'urne où étaient *renfermées* les cendres d'Hippias, il versa un torrent de larmes. FÉNELON.	*When he perceived the urn in which were enclosed the ashes of Hippias, he shed a torrent of tears.*

The participle past, having *avoir* as its auxiliary, never agrees with the subject :—

Vous riez? Écrivez qu'elle *a ri*. RACINE.	*You laugh? Put down that she laughed.*
Mes amis *ont parlé*; leurs cœurs sont attendris. VOLTAIRE.	*My friends have spoken; their hearts are moved.*
Mes cousines *ont lu*. BESCHERELLE.	*My cousins have read.*

The participle past, having *avoir* for an auxiliary, agrees with its direct object, when the latter precedes the auxiliary :—

La lettre *que* vous avez *écrite*.	*The letter which you have written.*
Pedro, qu'as-tu fait de nos montures?—Seigneur, je *les* ai *attachées* à la grille. LE SAGE.	*Pedro, what hast thou done with our horses?—My lord, I have fastened them to the grate.*
Les meilleures harangues sont celles *que* le cœur a *dictées*. MARMONTEL.	*The best addresses are those which the heart has dictated.*
Je *les* ai *cherchés* dans tous les coins, et je ne *les* ai pas *trouvés*. MME. DE GENLIS.	*I have sought them in every corner, but have not found them.*

But if the direct object is placed after the participle, this participle remains invariable :—

J'ai *reçu* votre *lettre*.	*I have received your letter.*
C'est la vérité elle-même qui lui a *dicté* ces belles *paroles*. BOSSUET.	*It is truth itself which has dictated to him those fine words.*
Les dieux ont *attaché* presque autant de *malheurs* à la liberté, qu'à la servitude. MONTESQUIEU.	*The gods have attached almost as many misfortunes to liberty as to servitude.*

REMARKS ON THE FOREGOING RULES.

Although the compound tenses of the reflective and reciprocal verbs take *être* as an auxiliary, the past participle of those verbs comes under the same rules as those conjugated with *avoir*, and agrees in gender and number with their direct object when it precedes the auxiliary, remaining invariable when it follows the past participle :—

Votre sœur s'est *acheté* de belles robes.	*Your sister has bought herself some handsome dresses.*
Cette femme s'est *rendue* malheureuse.	*That woman has rendered herself unhappy.*
Ils *se* sont *injuriés*.	*They abused each other.*

Acheté in the first example does not vary, because *se*, placed before the auxiliary, is indirect object, while the direct object, *robes*, is placed after the participle. *Rendue* in the second example varies, because the word *se*, representing *femme*, is a direct object, and precedes the auxiliary. *Injuriés* in the third example agrees with *se*, the reciprocal pronoun, because it is direct object and precedes *sont*, the auxiliary.

The past participle of naturally pronominal verbs *agrees with the subject* :—

La *maison* s'est *écroulée*.	*The house fell down.*

The naturally pronominal verb *s'arroger*, however, is an exception; its reflective pronoun being indirect object, and this verb admitting of a direct object, its past participle agrees with the latter according to the rules given above :—

Les priviléges *que* la reine s'était *arrogés* excitaient un mécontentement général.	*The privileges that the queen had arrogated to herself caused general dissatisfaction.*
Il y avait un an que le prince s'était *arrogé* ces *droits*.	*It was a year since the prince had arrogated those rights to himself.*

When pronominal reflective verbs, of which the second pronoun is indirect object, are accompanied by another pronoun, or by a noun used as direct object, the participle agrees with this pronoun or noun when it precedes the auxiliary, and remains invariable when the direct object follows it :—

Variable.	*Invariable.*
L'indiscrétion *que* nous nous sommes *reprochée*.	Nous nous sommes *reproché* l'*indiscrétion*.
The indiscretion with which we have reproached ourselves.	*We have reproached ourselves with the indiscretion.*

The verb *avoir*, followed by a past participle placed before an infinitive, may be preceded by the object of the past participle or by that of the infinitive : in the former case, the past participle agrees with the object; in the latter, it does not :—

Voici la dame *que* vous avez *entendue* chanter.	*Here is the lady whom you heard sing.*
Voici la chanson *que* vous avez *entendu* chanter.	*Here is the song which you heard sung.*

In the first instance, *que*, standing for *dame*, is object of *entendue*, which it governs. In the second, *que*, standing for *chanson*, is object of *chanter*, and does not govern *entendu*, which has an object understood—viz., *quelqu'un* : Voici la chanson que vous avez entendu (quelqu'un) chanter—*i.e.*, *Here is the song which you heard* (*somebody*) *sing*, or *which you heard sung* (*by somebody*).

To ascertain to which verb the object belongs, there is only to change the order of the sentence :—

Vous avez *entendu une dame* chanter, la voici.	*You have heard a lady sing, here she is.*
Vous avez entendu *chanter une chanson*, la voici.	*You have heard (somebody) sing a song, here it is.*

Or else the French sentence should be translated into English, and if then the French infinitive may be expressed in English by a past participle, the French past participle cannot agree :—

Variable.	*Invariable.*
Je *les* ai *vus* repousser les ennemis.	Je *les* ai *vu* repousser par les ennemis.
I saw them repel (repelling) the enemies.	*I saw them repelled by the enemies*
Je *les* ai *vus* prendre la fuite.	Je *les* ai *vu* prendre sur le fait.
I saw them taking flight.	*I saw them taken in the deed.*
Je *les* ai *vus* frapper.	Je *les* ai *vu* frapper.
I saw them striking.	*I saw them struck.*
Les personnes *que* j'ai *entendues* chanter.	Les chansons *que* j'ai *entendu* chanter.
The persons whom I heard singing.	*The songs which I heard sung.*

Exception to above Rule: When the verb *avoir*, followed by a past participle placed before an infinitive, is preceded by a direct object referring to a thing, and a personal pronoun referring to a person, the latter is indirect object, and the past participle does not agree :—

Chantez la chanson *que* nous lui avons *entendu* chanter.	*Sing the song that we have heard sung by her* (i.e., *that we have heard her sing*).

The past participle *fait*, when followed by an infinitive, the past participles *dû*, *voulu*, *pu*, when an infinitive is understood after them, do not agree :—

La maison qu'il a *fait* bâtir est belle.	*The house he has had built is beautiful.*
Il a obtenu toutes les graces qu'il a *voulu* (obtenir).	*He has obtained all the favours he wished (to obtain).*
Il n'a pas fait tous les efforts qu'il a *pu* (faire).	*He has not used all the endeavours he could (use).*
Elle n'a pas rempli tous les devoirs qu'elle aurait *dû* (remplir).	*She has not fulfilled all the duties which she ought (to have fulfilled).*

When, however, no infinitive is understood after *dû* and *voulu*, they agree with their object :—

On lui a accordé toutes les faveurs *qu'il* a *voulues*.	*They have granted to him all the favours he wanted.*
Il m'a payé les sommes *qu'il* m'a *dues* si longtemps.	*He has paid to me the sums he owed me so long.*

The past participles *coûté*, *valu* do not agree when used in their literal sense, but they do agree when used figuratively :—

La somme *que* ce cheval m'a *coûté*, il ne l'a jamais *valu*.	*The sum that this horse has cost me, he was never worth it* (i.e., *that horse was never worth the sum it cost me*).
Quels *avantages* cette charge vous a-t-elle *values*?	*What advantages has this office procured to you?*
Que de *peines* elle vous a *coûtées*!	*What troubles it cost you!*

A past participle preceded and followed by *que*, or between *que* and *qui*, does not agree :—

La chimie *que* vous avez *voulu que* j'étudie	*Chemistry which you wished me to study.*
Avez-vous reçu les estampes *que* je vous ai *informé qui* vous avaient été expédiées?	*Have you received the engravings which, as I informed you, had been forwarded to you?*

The participles past of neuter verbs, conjugated with *avoir*, and those of impersonal verbs, are always invariable :—

Que de bien n'a-t-elle pas fait, pendant le peu de jours qu'elle a *régné*! FLÉCHIER.	*How much good has she not done, during the few days that she reigned!*
Les chaleurs excessives qu'il a *fait*, ont causé beaucoup de maladies. CONDILLAC	*The excessive heat which we have had, has caused much sickness.*

A past participle having the pronoun *en* as object does not agree :—

Avez-vous mangé des fruits? J'*en* ai *mangé*.	*Have you eaten some fruits? I have eaten some.*
Tout le monde m'a offert des services, et personne ne m'*en* a *rendu*. MME. DE MAINTENON.	*Everybody tendered me services, and no person rendered me any.*

It does not agree either when, *en* being used with an adverb of quantity, the latter follows the auxiliary or the past participle :—

Je n'avais plus d'hameçons, mais j'*en* ai beaucoup *acheté*.	*I had no more fish-hooks, but I have bought many.*
Il n'avait plus de chevaux, mais il *en* a *acheté* plusieurs.	*He had no more horses, but he has bought several.*

The presence of *en* does not, however, prevent the past participle from agreeing—1st, When it has a direct object preceding its auxiliary :—

Cassius, naturellement fier et impérieux, ne cherchait dans la perte de César que la vengeance de quelques injures *qu'il en avait reçues*. VERTOT.	*Cassius, naturally proud and imperious, sought in the death of Cæsar only revenge for some injuries which he had received from him.*
Rendez grâces au ciel qui *nous-en a vengés*. CORNEILLE.	*Render thanks to Heaven, which has avenged us for it.*

2ndly, When, being joined to an adverb of quantity, the latter precedes the auxiliary :—

Plus il a eu de livres, plus il *en a lus*.	*The more books he has had, the more he has read.*
Plus il a eu d'amis, moins il *en a conservés*.	*The more friends he has had, the fewer he has preserved.*

Le peu has in French two meanings: it signifies *a small quantity*, or *lack*, *absence*.

When it signifies *a small quantity*, the participle agrees with the noun which follows *le peu* :—

Le peu d'*affection* que vous lui avez *témoignée*, lui a rendu le courage.	*The little affection which you have shown him, has restored his courage.*

When *le peu* is used in the sense of *lack*, *absence*, the participle remains unaltered :—

Le peu d'affection que vous lui avez *témoigné*, l'a découragé.	*The lack of affection which you have shown him; has discouraged him*

The past participles supposé, *supposed*; excepté, *except*; passé, *past*; compris, *including*; joint, inclus, *annexed*, *inclosed*; when their auxiliary is understood, agree with the noun when it precedes them, and remain invariable when it follows them :—

Vous trouverez *ci-joint* la copie de la lettre que M. . . . m'a ecrite. J. J. ROUSSEAU.	*You will find annexed the copy of the letter which M. . . has written to me.*
Le dessin de cet oiseau m'a été envoyé d'Angleterre, avec la description *ci-jointe*. BUFFON.	*The drawing of that bird came to me from England with the description here annexed.*
Vous trouverez *ci-inclus*, une copie de ma lettre. DOMERGUES.	*You will find enclosed, a copy of my letter.*
Je vous recommande les cinq lettres *ci-incluses*. BERNARDIN DE ST. PIERRE.	*I recommend to you the five letters enclosed.*

The Adverb.

The adverb is an invariable word joined to verbs, adjectives, or to other adverbs, to modify their signification.

Adverbs are divided into eight classes :—

1. Of manner:	doucement, *softly;* sagement, *wisely,* etc.
2. Of order:	premièrement, *first;* d'abord, *at first;* ensuite, *afterwards,* etc.
3. Of place:	ici, *here;* où, *where;* là, *there;* ailleurs, *elsewhere,* etc.
4. Of time:	hier, *yesterday;* aujourd'hui, *to-day;* demain, *to-morrow,* etc.
5. Of quantity:	peu, *little;* trop, *too much;* beaucoup, *much, many,* etc.
6. Of comparison:	plus, *more;* moins, *less;* autant, *as much as many,* etc.
7. Of affirmation, interrogation, negation, and doubt:	oui, *yes;* certes, *certainly;* comment, *how;* non, *no;* nullement, *by no means;* peut-être, *perhaps;* ne, pas, point, *not,* etc.
8. Of intensity:	bien, *well;* très, fort, *very;* tant, *so much,* etc.

NOTE.—Adverbs of quantity require the preposition *de* to be placed, for both genders and numbers, before the noun they qualify :—

Elle a beaucoup d'esprit.	*She has much wit.*
J'ai peu d'amis.	*I have few friends.*

A few adjectives are sometimes used adverbially. They are then invariable :—

chanter *juste,*	*to sing in tune.*
coûter *cher,*	*to cost dear.*
parler *haut,*	*to speak loud.*

Several words united together, and having the force of an adverb, are called an adverbial phrase :—

tout à coup,	*suddenly*
peu à peu,	*by degrees.*
tout à l'heure,	*immediately*
de temps en temps,	*now and then,* etc.

Formation of Adverbs from Adjectives.

Adverbs of manner are formed from adjectives by adding *-ment* to the latter.

When the adjective ends in the masculine with a vowel, *-ment* is added to the adjective without any change in the latter :—

Adjective.		*Adverb.*	
utile,	*useful;*	utilement,	*usefully.*
poli,	*polite;*	poliment,	*politely.*
aisé,	*easy;*	aisément,	*easily.*

Exceptions:

beau,	*beautiful;*	bellement,	*beautifully.*
fou,	*foolish;*	follement,	*foolishly.*
mou,	*soft;*	mollement,	*softly.*
nouveau,	*new;*	nouvellement,	*newly.*
traître,	*treacherous;*	traîtreusement,	*treacherously.*

When the adjective ends in the masculine with a consonant, the syllable *-ment* is added to its feminine termination; as—

masc.	*fem.*			
bon,	bonne,	*good;*	bonnement,	*in a good manner.*
doux,	douce,	*soft;*	doucement,	*softly.*
heureux,	heureuse,	*happy;*	heureusement,	*happily.*

When the adjectives end in *-nt,* that termination is changed into *m,* and then *-ment* is added :—

prudent,	*prudent;*	prudemment,	*prudently.*
élégant,	*elegant;*	élégamment	*elegantly.*

Exceptions.

lent,	*slow;*	lentement,	*slowly.*
présent,	*present;*	présentement,	*presently.*
véhément,	*vehement;*	véhémentement,	*vehemently.*

The following adverbs require an acute accent over the *e* preceding *-ment,* which *e* is mute in the adjective :—

aveuglément,	*blindly.*
commodément,	*commodiously*
communément,	*commonly.*
conformément,	*conformably.*
confusément,	*confusedly.*
diffusément,	*diffusely.*
énormément,	*enormously.*
expressément,	*expressly.*
importunément,	*importunately.*
incommodément,	*incommodiously.*
obscurément,	*obscurely.*
opiniâtrement,	*obstinately.*
précisément,	*precisely.*
profondément,	*profoundly.*

Gentil, *pretty,* forms its adverb by dropping its final *l* and adding *-ment:* genti*ment.*

The origin of the termination *-ment* may be briefly stated. You will remember that adverbs in Latin generally end in *-e* or *-ter.* In French these terminations were dropped, as they had no accent, and their place was taken by *-ment,* which is nothing else than an abbreviated form of *mente,* the ablative singular of *mens.* Thus *bonâ mente* and *devotâ mente,* which mean little more than *well* or *devotedly,* appear in French as *bonnement* and *dévotement.*

Degrees of Signification in Adverbs ending in -ment.

Adverbs ending in *-ment* are, like the adjectives from which they are formed, susceptible of three degrees of signification: the positive, the comparative, and the superlative.

The first expresses the manner simply.

The second expresses it in a degree of equality, superiority, or inferiority, by adding to the adverb the words aussi, *as;* plus, *more;* moins, *less.*

The third, by the addition of the words bien, très, fort, *very,* etc., carries that signification to the highest degree without conveying any idea of comparison; or with an idea of comparison, by placing le plus, *most,* before the adverbs.

Adverbs expressing Comparison.

The following adverbs express the idea of comparison in one or other of the three degrees :—

comme, de même, pareillement,	*in the same manner.*	ainsi,	*thus.*
		plus, davantage,	*more.*

de plus,	*besides.*	à peu près,	*nearly.*
moins,	*less.*	tout au plus,	*at most.*
mieux,	*better.*	à qui mieux mieux,	*vying with one another.*
pis,	*worse.*	à l'envi,	*vying with one another.*
très,	*very.*	de mieux en mieux,	*better and better.*
ni plus ni moins,	*neither more nor less.*		
presque, quasi,	*almost.*		

The Adverb.—Its Place.

In French the adverb used to modify a verb in a simple tense is generally placed after the verb:—

Que de gens prennent *hardiment* le masque de la vertu! SCUDÉRI.	*How many people boldly assume the mask of virtue!*

This is not the universal custom in English.

Adverbs of place, and those used in interrogations, have the same place in French as in English:—

Où est votre frère? Il est *ici*.	*Where is your brother? He is here.*

In compound tenses the adverb is placed between the auxiliary and the participle:—

Vous avez *mal* fait.	*You have done wrong.*
Il nous a *bien* reçus.	*He received us well.*

Adverbs of manner ending in *-ment* may, in compound tenses, be placed before the participle, or after it when they are very long, or followed by other modifying words. When, however, they are followed by such words, it is better to introduce the clause or sentence by the adverb:—

Cela est *heureusement* exprimé. / Cela est exprimé *heureusement*	*That is happily expressed.*
Heureusement il est venu à temps	*He came fortunately in time.*

The adverbs **aujourd'hui**, *to-day*; **demain**, *to-morrow*; **hier**, *yesterday*, may be placed before or after the verb, but never between the auxiliary and the participle. The adverb **davantage**, *more*, follows the participle:—

Nous sommes arrivés *aujourd'hui*.	*We arrived to-day.*
Votre frere s'est blessé *hier*.	*Your brother hurt himself yesterday.*
Aujourd'hui il fait beau temps; *demain* il pleuvra. GIRAULT DUVIVIER.	*To-day it is fine weather; to-morrow it will rain.*

KEY TO TRANSLATION FROM FRENCH (p. 165).

The Coach and the Fly.

On a bad road, up-hill, and sandy, exposed on all sides to the sun, six strong horses were dragging a coach: Women, monks, old men, had all got down. The team sweated, puffed, was used up. A fly comes up and approaches the horses; pretends to enliven them by her buzzing; stings first one, and then the other, and thinks all the time that she is causing the equipage to move. She sits on the pole, on the nose of the coachman. As soon as the chariot moves, and she sees the people walking, she attributes the glory of it to herself alone: goes, comes, takes a lot of trouble; it seems as if she were an army sergeant—going everywhere to cause her men to advance, to hasten on the victory. The fly in this common need complains that she is doing it alone, and that she has all the trouble; that no one helps the horses to get through their work. The monk was saying his breviary; he was taking his own time comfortably! A woman was singing; there was something else to think of then than songs. Dame Fly goes about singing in their ears, and doing a hundred of foolish things like that. After much labour, the coach arrives at the top. "Now, let us take breath!" says the fly at this moment. "I have done so much that our people are at last on level ground. Then, masters, pay me for my trouble." In this way certain people, making themselves officious, intrude themselves in (other people's) affairs. They do unnecessary things everywhere, and, everywhere a nuisance, ought to be driven away.

LOGARITHMS.—I.

DERIVATION OF NAME—USE—NATURE OF POWERS.

1. *Derivation of the Name.*—The word "logarithm" is derived from two Greek words, signifying *number* and *ratio*. The fundamental theory of the system is that a certain fixed number, called a *base*, raised to the proper power, may be made to represent any number required.

2. *Use of the Method.*—By the use of logarithms, the more tedious calculations of arithmetic are simplified, the longer processes of multiplication and division being converted into the shorter and easier processes of addition or subtraction, and a simple method provided for the otherwise difficult operations of involution or evolution.

3. *Nature of Powers.*—If unity be multiplied by any number, the product is called the first power of the number; thus—

$$6 \times 1 = 6, \text{ the first power.}$$

If the first power be multiplied by the number, the product is called the second power, or *square*; thus—

$$6 \times 6 = 36, \text{ the second power.}$$

This is also written 6^2, the figure written above the line being called the *index* of the power, because it *indicates* the times which the number has been repeated to form that power.

If the second power be multiplied again by the original number, the product is called the third power, or *cube*; thus—

$$6 \times 6 \times 6 = 6^3 = 216;$$

and so on. Hence the following table will show the powers of the number 6:—

$6 \times 1 = 6^1 =$	6,	the 1st	power.
$6^1 \times 6 = 6^2 =$	36,	,, 2nd	,,
$6^2 \times 6 = 6^3 =$	216,	,, 3rd	,,
$6^3 \times 6 = 6^4 =$	1296,	,, 4th	,,
$6^4 \times 6 = 6^5 =$	7776,	,, 5th	,,
$6^5 \times 6 = 6^6 =$	46656,	,, 6th	,,

This process is called *involution*. It is obvious that it may be carried to any extent, and that by it is provided an abbreviated method of writing and

dealing with large numbers. Thus, for the fifth power of 6, which is 7776, we write 6^5; and if we wish to multiply 7776 by 1296, we do so by means of 6^5 and 6^4, and obtain the result, as we shall presently prove, in the form 6^9.

4. *Nature of Roots.*—We have seen that the products obtained by multiplying a number by itself over and over again are called its powers. The number itself, in its relation to these powers, is called the *root*. Thus, while 36 is the square of 6, 6 is called the *square root* of 36. So, while 216 is the cube of 6, 6 is the *cube root* of 216. So, again, 1296 is the fourth power of 6, 6 is the *fourth root* of 1296; and so on to any extent. The process by which the root is obtained from any number is called *evolution*. We may remark that, while involution is possible for any number, evolution is only possible for those numbers which are themselves *exact powers* of smaller numbers.

5. We have remarked above that, in indicating the power of a number, a small figure is written above the line. Thus, 6^4 indicates that four sixes have been multiplied together to form what is called the fourth power of 6. The same method is employed to indicate evolution, but in this case the indices are fractions whose numerators are unity, and whose denominators indicate the root which has to be extracted; thus, while

$6^4 = 1296 =$ 4th power of 6; $1296^{\frac{1}{4}} = 6 =$ 4th root of 1296.

So again—

$6^5 = 7776 =$ 5th power of 6; $7776^{\frac{1}{5}} = 6 =$ 5th root of 7776.

6. We add, for the sake of illustration, a table of the powers of the number 3:—

$3 \times 1 = 3^1 =$	3,	the 1st power.
$3 \times 3 = 3^2 =$	9,	„ 2nd „
$3^2 \times 3 = 3^3 =$	27,	„ 3rd „
$3^3 \times 3 = 3^4 =$	81,	„ 4th „
$3^4 \times 3 = 3^5 =$	243,	„ 5th „
$3^5 \times 3 = 3^6 =$	729,	„ 6th „
$3^6 \times 3 = 3^7 =$	2187,	„ 7th „
$3^7 \times 3 = 3^8 =$	6561,	„ 8th „
$3^8 \times 3 = 3^9 =$	19683,	„ 9th „
$3^9 \times 3 = 3^{10} =$	59049,	„ 10th „
$3^{10} \times 3 = 3^{11} =$	177147,	„ 11th „
$3^{11} \times 3 = 3^{12} =$	531441,	„ 12th „

7. The following is a table of the fractional indices by which the relation of the root 3 to its powers is indicated:—

$531441^{\frac{1}{12}} = 3 =$	12th root of	531441.
$177147^{\frac{1}{11}} = 3 =$	11th „	177147.
$59049^{\frac{1}{10}} = 3 =$	10th „	59049.
$19683^{\frac{1}{9}} = 3 =$	9th „	19683.
$6561^{\frac{1}{8}} = 3 =$	8th „	6561.
$2187^{\frac{1}{7}} = 3 =$	7th „	2187.
$729^{\frac{1}{6}} = 3 =$	6th „	729.
$243^{\frac{1}{5}} = 3 =$	5th root of	243.
$81^{\frac{1}{4}} = 3 =$	4th „	81.
$27^{\frac{1}{3}} = 3 =$	3rd „	27.
$9^{\frac{1}{2}} = 3 =$	2nd „	9.

8. We have pointed out that 6^5 indicates that five sixes have been multiplied together to form the quantities which it represents; and similarly with 6^4. Hence it is obvious that to multiply 6^5 by 6^4 we should have to multiply the product of five sixes by the product of four sixes—obtaining, obviously, the product of nine sixes, or 6^9. Hence a simple rule to multiply two powers of the same number:—*Add their indices.*

9. The same rule applies for fractional indices—that is, for roots; thus—

$$729^{\frac{1}{6}} = 3;\ 729^{\frac{1}{3}} = 9.$$

$$729^{\frac{1}{3}} \times 729^{\frac{1}{6}} = 9 \times 3;\ \text{or } 729^{\frac{1}{3} + \frac{1}{6}} = 729^{\frac{1}{2}} = 27.$$

10. In a similar way, the division of quantities expressed in the form of powers of the same number is accomplished by the subtraction of the less from the greater index. Thus 6^5 indicates five sixes multiplied together; 6^4 the same for four sixes. Hence if 6^4 be written as a denominator, it is evident that the four sixes of which it is composed will cut out four of those of which 6^5 is composed, and leave in the numerator only 1 (or $5-4$); thus—

$$\frac{6^5}{6^4} = \frac{6 \times 6 \times 6 \times 6 \times 6}{6 \times 6 \times 6 \times 6} = 6$$

Hence the above rule—*To divide one power of a number by another, subtract the lesser from the greater index.*

11. The same rule holds for fractional indices—that is, for roots; thus—

$$729^{\frac{1}{3}} \div 729^{\frac{1}{6}} = 9 \div 3;\ \text{or } 729^{\frac{1}{3} - \frac{1}{6}} = 729^{\frac{1}{6}} = 3.$$

12. We have seen that the multiplication or division of powers of a number is effected by the addition or subtraction of their indices. We naturally ask, what is the effect if indices be multiplied together? We shall answer this question most easily by remembering that multiplication is only an abbreviated form of addition. Thus, if we multiply 2 by 4, we do in reality only add together four twos:—

$$4 \times 2 = 2 + 2 + 2 + 2.$$

And so, if we have 6^2 and 6^4, and multiply together their indices, we have in reality done the same as if we had added the indices of 6^2, 6^2, 6^2, 6^2, or of 6^4, 6^4—that is, we have done the same as raise 6^2 to its fourth power, or 6^4 to its second power. Hence it is obvious that when the index of any power is multiplied by any quantity, that power is itself raised to the power of that quantity; thus—

$$6^{2 \times 4} = (6^2)^4 = 36^4;\ \text{and } 6^{4 \times 2} = (6^4)^2 = 1296^2$$

13. We are now in a position to determine the meanings of fractional indices whose numerators are not unity; thus—

$$6^{\frac{4}{3}} = (6^{\frac{1}{3}})^4 = (6^4)^{\frac{1}{3}};$$

that is, the fourth power of the cube root of 6, or the cube root of the fourth power of 6. As an example, take—

$$27^{\frac{2}{3}} = (27^2)^{\frac{1}{3}} = (729)^{\frac{1}{3}} = 9; \text{ or } 27^{\frac{2}{3}} = (27^{\frac{1}{3}})^2 \ (=3)^2 = 9.$$

14. It will be observed that we have made no reference to the index 0. Remembering that any number divided by itself gives unity as a quotient, we have—

$$6^6 - 6^6 = 6^{6-6} = 6^0 = 1.$$

Hence we arrive at the apparent paradox that any number raised to the zero power is equal to unity—an arithmetical curiosity, which the reader must be content to receive without further explanation.

NATURE AND USE.

15. Hitherto we have dealt with numbers and their powers, and have illustrated the use of logarithms by the manipulation of indices, whether whole or fractional numbers. We proceed now to a further definition of logarithms.

16. Given a fixed number, called a *base*. The logarithm of a number with regard to that base is the index of the power to which the base must be raised in order to produce the number.

17. If 2 be assumed as a base, then the powers of 2 will be the *natural numbers*, and the *indices* of those powers will be the *logarithms* of the natural numbers; thus—

TABLE OF LOGARITHMS TO BASE 2.

Natural Nos.	Logarithms.	Natural Nos.	Logarithms.
1	0	128	7
2	1	256	8
4	2	512	9
8	3	1024	10
16	4	2048	11
32	5	4096	12
64	6		

18. By means of this table, logarithmic calculations may be exemplified on a small scale, in the following manner:—

19. (*a*) *To Multiply two or more Numbers together.*—If the logarithms of the factors be added together, the sum is the logarithm of the product. Thus, to multiply 128 by 8, add 7 and 3 together, the logarithms of the factors; the sum 10 is the logarithm of the product 1024. Again, to multiply 4, 8, and 16 continuously together, add 2, 3, and 4 together, the logarithms of the factors; the sum 9 is the logarithm of the product 512.

20. (*b*) *To Divide one number by another.*—If the logarithm of the divisor be subtracted from the logarithm of the dividend, the remainder is the logarithm of the quotient. Thus, to divide 256 by 64, subtract 6, the logarithm of the divisor, from 8, the logarithm of the dividend; the remainder 2 is the logarithm of the quotient 4.

21. (*c*) *To find a fourth Proportional to three given Terms.*—If the logarithms of the second and third terms be added together, and from the sum the logarithm of the first term be subtracted, the remainder is the logarithm of the fourth term. For example, to find a fourth proportional to 8, 32, and 64:—If 8 : 32 : : 64 : the fourth term; then add 5 and 6 together, the logarithms of the second and third terms, and from the sum 11 subtract 3, the logarithm of the first term; the remainder 8 is the logarithm of the fourth term 256.

22. (*d*) *To find any Power of a Number.*—If the logarithm of the number be multiplied by the index of the required power, the product is the logarithm of that power. Thus, to find the square of 16, multiply 4, the logarithm of the number, by 2, the index of the square; the product 8 is the logarithm of the square 256.

23. (*e*) *To find any Root of a Number.*—If the logarithm of the number be multiplied by the index of the required root, or be divided by its denominator, the quotient is the logarithm of that root. Thus, to find the cube root of 64, divide 6, the logarithm of the number, by 3, the denominator of the index of the cube root; the quotient 2 is the logarithm of the cube root 4.

24. The nature and use of logarithms having been thus illustrated and exemplified in the system of which the base is 2, we shall now give a full explanation of the system in common use.

COMMON SYSTEM OF LOGARITHMS.

25. The number 10 has been assumed as the *base* of the common system of logarithms, because it is the *root* of the decimal scale of notation, and on this account possesses certain advantages which have led to its universal adoption by mathematicians.

26. The powers of the number 10 being respectively unity with as many ciphers annexed as are denoted by the indices of the different powers, the construction of the following table is sufficiently evident to the student:—

TABLE OF POWERS.

	Power.		Power.
$10^0 = 1$	Zero	$10^7 = 10000000$	7th
$10^1 = 10$	1st	$10^8 = 100000000$	8th
$10^2 = 100$	2nd	$10^9 = 1000000000$	9th
$10^3 = 1000$	3rd	$10^{10} = 10000000000$	10th
$10^4 = 10000$	4th	$10^{11} = 100000000000$	11th
$10^5 = 100000$	5th	$10^{12} = 1000000000000$	12th
$10^6 = 1000000$	6th	etc.	

27. These powers of 10 being the *natural numbers*, and their *indices* the *logarithms* of those numbers, the construction of the following table is rendered evident by the table in the preceding article:—

FIRST SKELETON TABLE OF LOGARITHMS TO BASE 10.

Natural Nos.	Logarithms.	Natural Nos.	Logarithms.
1	0	10000000	7
10	1	100000000	8
100	2	1000000000	9
1000	3	10000000000	10
10000	4	100000000000	11
100000	5	1000000000000	12
1000000	6	etc.	

28. If unity, the first natural number, be divided by the successive natural numbers in the preceding table, the quotients will be a series of decimal fractions—viz., ·1, ·01, ·001, etc. The logarithms of these quotients will be found by subtracting the logarithms of the natural numbers of 0, the logarithm of unity. Now though it be impossible, arithmetically, to subtract the logarithms 1, 2, 3, etc., from the logarithm 0, yet the operation that should be performed is indicated by placing the sign of subtraction before each of these logarithms; thus, —1, —2, —3, etc. Hence, the construction of the following table of decimal fractions, with their logarithms, is evident to the student:—

SECOND SKELETON TABLE OF LOGARITHMS TO BASE 10.

Natural Nos.	Logarithms.	Natural Nos.	Logarithms.
·1	—1	·0000001	—7
·01	—2	·00000001	—8
·001	—3	·000000001	—9
·0001	—4	·0000000001	—10
·00001	—5	·00000000001	—11
·000001	—6	·000000000001	—12, etc.

29. These logarithms, being of an opposite character to the former, are called *negative*, while the former are denominated *positive*. From the remarks in the preceding article, it is evident that the logarithm of every proper fraction is essentially negative, and that the logarithms of such fractions numerically increase in proportion as the fractions themselves decrease in value, compared with unity. Hence, when the value of a fraction is indefinitely small, its logarithm, numerically considered, must be indefinitely great; and when the value of a fraction is infinitely small, so as to be reckoned equal to nothing, its logarithm must be infinitely great; in other words, the logarithm of 0 is negative infinity.

30. If the square root of the number 10 be extracted, and then the square root of this root; and of each successive root, the indices of these roots will be the successive powers of $\frac{1}{2}$, the index of the square root. Thus, by the common rule for extracting the square root, we have, going as far as five places of decimals—

Square root of 10·00000 = 3·16228, index $\frac{1}{2}$.
" " 3·16228 = 1·77828, " $\frac{1}{4}$.
" " 1·77828 = 1·33352, " $\frac{1}{8}$.
" " 1·33352 = 1·15478, " $\frac{1}{16}$.
" " 1·15478 = 1·07461, " $\frac{1}{32}$.
" " 1·07461 = 1·03663, " $\frac{1}{64}$; etc.

On this principle the following table is constructed:—

TABLE OF EVEN ROOTS.

$10^{\frac{1}{2}}$ = 3·16228, sq. root.	$10^{\frac{1}{16}}$ = 1·15478, 16th root.
$10^{\frac{1}{4}}$ = 1·77828, 4th root.	$10^{\frac{1}{32}}$ = 1·07461, 32nd root.
$10^{\frac{1}{8}}$ = 1·33352, 8th root.	$10^{\frac{1}{64}}$ = 1·03663, 64th root; etc.

31. If the cube root of the number 10 be extracted, and then the cube root of this root, and of each successive root, the indices of these roots will be the successive powers of $\frac{1}{3}$, the index of the cube root. Thus, by the common rule for extracting the cube root, we have—

Cube root of 10·00000 = 2·15443, index $\frac{1}{3}$.
" " 2·15443 = 1·29155, " $\frac{1}{9}$.
" " 1·29155 = 1·08902, " $\frac{1}{27}$.
" " 1·08902 = 1·02883, " $\frac{1}{81}$.
" " 1·02883 = 1·00952, " $\frac{1}{243}$.
" " 1·00952 = 1·00316, " $\frac{1}{729}$; etc.

On this principle the following table is constructed:—

TABLE OF ODD ROOTS.

$10^{\frac{1}{3}}$ = 2·15443, the cube root.
$10^{\frac{1}{9}}$ = 1·29155, the 9th root.
$10^{\frac{1}{27}}$ = 1·08902, the 27th root.
$10^{\frac{1}{81}}$ = 1·02883, the 81st root.
$10^{\frac{1}{243}}$ = 1·00952, the 243rd root.
$10^{\frac{1}{729}}$ = 1·00316, the 729th root; etc.

32. The *roots* or *fractional powers* of 10, in the two preceding tables, are *natural numbers*, and their *indices* the *logarithms* of those numbers. Hence the construction of the following skeleton table, composed of two parts, is thus rendered evident; for Part I. is deduced from the *Table of Even Roots*, extended by means of eighteen successive extractions of the square root, as directed in Art. 30; the left-hand column containing the roots or numbers thus obtained, and the right-hand column the decimals approximately equivalent to the fractional indices of those roots or numbers. In like manner, Part II. is deduced from the *Table of Odd Roots*, extended by means of eleven extractions of the cube root, as directed in Art. 31; the left-hand column containing the roots or numbers thus obtained, and the right-hand column the decimals approximately equivalent to the fractional indices of those roots or numbers:—

THIRD SKELETON TABLE OF LOGARITHMS.

Part I.

Natural Nos.	Logarithms.	Natural Nos.	Logarithms.
3·16228	·500000	1·00225	·000977
1·77828	·250000	1·00113	·000488
1·33352	·125000	1·00056	·000244
1·15478	·062500	1·00028	·000122
1·07461	·031250	1·00014	·000061
1·03663	·015625	1·00007	·000031
1·01815	·007813	1·00004	·000015
1·00904	·003906	1·00002	·000008
1·00451	·001953	1·00001	·000004
		etc.	etc.

Part II.

Natural Nos.	Logarithms.	Natural Nos.	Logarithms.
2·15443	·333333	1·00105	·000457
1·29155	·111111	1·00035	·000152
1·08902	·037037	1·00012	·000051
1·02883	·012346	1·00004	·000017
1·00953	·004115	1·00001	·000005
1·00316	·001372	etc.	etc.

33. By means of these three skeleton tables, and the principles already explained, the logarithms of all natural numbers may be found to any extent required, within certain limits as to the number of decimal figures.

COMMON SYSTEM OF LOGARITHMS.

34. *To find the Logarithm of any Prime Number.*

RULE 1.

Divide the given prime number by the natural number nearest to it in the skeleton tables, but less; divide the quotient by the natural number nearest to it, but less; divide this quotient by the natural number nearest to it, but less; and so on, till the last quotient coincide with some natural number in the tables; then, the last quotient with all the divisors are the tabular factors of which the prime number is composed. Consequently if the logarithms of all these factors, given in the tables, be added together, their sum will be the logarithm of the given prime number. On this principle the following table, exhibiting the method of calculating the logarithm of the prime number 2, is constructed:—

FIRST CALCULATION OF THE LOGARITHM OF 2.

Dividends.		Divisors.		Quotients.	Logs. of Divisors.
2·00000	÷	1·77828	=	1·12468	·250000
1·12468	÷	1·07461	=	1·04660	·031250
1·04660	÷	1·03663	=	1·00961	·015625
1·00961	÷	1·00901	=	1·00057	·003906
1·00057	÷	1·00056	=	1·00001	·000244
1·00001	÷	1·00001	=	1·00000	·000004
				Logarithm of 2 = Sum	·301029

35. *To find the Logarithm of any Prime Number.*

RULE 2.

Look for the tabular number nearest to the given prime number, but greater; divide the former by the latter; divide the quotient by the tabular number nearest it, but less; and so on, as before, till the last quotient coincide with some tabular number; then, the last quotient with all the divisors but the first are the tabular factors of the first quotient. Consequently, if the sum of the logarithms of these factors, which is the logarithm of the first quotient, be subtracted from the logarithm of the first dividend, the remainder will be the logarithm of the given prime number. On this principle the following table, exhibiting another method of calculating the logarithm of 2, is constructed:—

SECOND CALCULATION OF THE LOGARITHM OF 2.

Dividends.		Divisors.		Quotients.	Logs. of Divisors.
2·15443	÷	2·00000	=	1·07722	·333333
1·07772	÷	1·07461	=	1·00243	·031250
1·00243	÷	1·00225	=	1·00018	·000977
1·00018	÷	1·00014	=	1·00004	·000061
1·00004	÷	1·00004	=	1·00000	·000015
				Sum of the logarithms of the factors	·032303
				Logarithms of 2 = Remainder	·301030

The latter logarithm of 2 is more correct than the former, owing to the difference in the mode of calculation. The logarithm of 2, calculated to ten places of decimals, is ·3010299957.

36. As the prime number 5 is the quotient of 10 divided by 2, its logarithm is found on the principle that if the logarithm of the dividend be subtracted from the logarithm of the divisor, the remainder is the logarithm of the quotient (*see* Art. 20). Hence the reason of the following calculation is made evident:—

$$\begin{array}{lr} \text{Logarithm of } 10 = & 1\cdot000000 \\ \text{,,} \qquad 2 = & \cdot301030 \\ \hline \text{,,} \qquad 5 = & \cdot698970 \end{array}$$

ENGLISH.—XXVIII.

[*Continued from p. 182.*]

VARIOUS FORMS OF THE SUBJECT OF A PROPOSITION.

WE now come to the noun *man* in our model sentence—

The sick man copiously drinks.

The noun *man* is the subject to the verb *drinks*. We thus see that a noun may be the subject of a proposition. Is there any other part of speech that may be the subject of a proposition?

(1) An adjective may be the subject of a proposition: as—

The sick drink.

But here it must be observed that for *drinks* we have substituted *drink*, the plural for the singular form of the verb. The rule then is, that *adjectives, when used in the plural, and preceded by the definite article, may be the subject of a proposition.*

(2) A pronoun may be the subject of a proposition: as—

I, the sick man, drink.

Here *I* is the subject to the verb *drink*; as, *I drink*. So we may say—

You, the sick man, drink.
I, you, we, they drink.

These additions to the subject modify the signification, and offer instances of what is called *apposition*. Apposition (from ad, *to*, and pono, *I place*) exists when a noun is added to a

pronoun or a noun in order to explain the intended meaning. Thus here it is not *I* merely that drinks, but *I, the sick man*. Instead of a pronoun, you may have a noun: as—

Alexander, the son of Philip, conquered Darius.

Apposition takes place in the object as well as in the sentence, as in this sentence—

Wine overcame Alexander, *the son of Philip.*

(3) An infinitive mood may be the subject of a proposition: as—

To labour is pleasant.

Other words may be connected with the infinitive mood: as—

A Noun.—To drink *water* is pleasant.
A Noun and Adjective.—To drink *good water* is wholesome.
A Noun, Adjective, and Adverb.—To drink *good water copiously* is wholesome.

The so-called infinitive mood is better described when thus used as a verbal noun.

(4) A verbal noun ending in *-ing* may be the subject of a proposition: as—

Drinking is bad.

Drinking has here the force of a noun, while it retains also its verbal force. That it is a noun is clear from its being the subject to the verb *is.* That it has also the force of a verb is clear from its power to govern an object: as—

Drinking *spirits* is bad.

As a noun, *drinking* may be qualified by an article, an adjective, and a personal pronoun: as—

Article.—*The* drinking was injurious.
Adjective.—*Much* drinking is very injurious.
Pers. Pron.—*His* drinking has been injurious to him.

Equally may the verbal force carry with it words qualifying the object: as—

Drinking *pure water* is wholesome.
Drinking *even a glass of wine* may be blamed.

This last sentence presents a subject compounded of several words; for the subject to the verb *may* is the clause *drinking even a glass of wine.*

When this verbal noun has the article connected with it, it in a measure loses its verbal force, and, becoming a noun, is connected with a second noun by means of a preposition: as—

The driving *of* the cattle was blamed.

The subject of a sentence is sometimes a proposition, or several words introduced by an adverb or a preposition. Such subjects are likely to give the learner trouble; we, therefore, give specimens, marking the words which form the several subjects.

COMPOUND OR ADVERBIAL SUBJECTS.

Subject.	*Predicate.*
That too much care can injure	is a dangerous doctrine.
By what means I may serve you	is unknown to me.
For a prince to be reduced	is a great calamity.

POSITION OF THE SUBJECT AND ITS AGREEMENT WITH THE VERB.

Position of the Subject.—The ordinary place of the subject is immediately before the verb: as—

The *sick man* drinks.

One word or more may intervene before the subject.

The subject, however, comes after the verb (1) in questions: as in this example—

Does the sick man drink wine?

(2) With the imperative mood: as—

Go thou; *come* ye.

(3) On the expression of a strong wish: as—

May they learn wisdom by what they suffer.

(4) When the conjunction *if* is dropped as—

Were my father alive, for "if my father were," etc.

(5) With the conjunction *nor*: as—

Nor can your turpitude be denied.

(6) In cases of emphasis: as—

Rich is the reward of the righteous.

(7) After an adverb or adverbial phrase: as—

After the infantry marched the grenadiers, then followed the horse.

(8) With an interposed verb: as—

"My children," *replied* the dying father, "I entreat you."

The imperative mood of the first and third person singular and plural is formed with the assistance of *let*: as—

Let him go; *let* them eat.

Here, it will be observed, the pronouns are in the objective case. The reason is that *let* is really an independent verb, and as such governs the objects *him* and *them* in the objective case, *go* and *eat* being infinitives depending on *let.* This is the true analysis of such sentences.

When an adverb begins a sentence, the subject may be put after its verb: as—

"*There* will I plead with you face to face." (Ezek. xx. 35.)

Yet by no means universally: as—

"There *they* buried Abraham and Sarah." (Gen. xlix. 31)

When, however, *there* is used as an expletive, the subject follows the verb: as—

"*There* shall be no night there." (Rev. xxi. 25)

"An expletive" is a word which, according to its derivation, signifies *a word which fills* up or is redundant. A regard to idiom may sometimes require the retention of expletives.

After adverbial phrases the subject most frequently takes its place after the verb.

AGREEMENT OF THE SUBJECT AND VERB.

While the subject of a proposition may agree with a qualifying adjective and a limiting or defining article, it specially agrees with the verb. The agreement is of two kinds—one of form, another of substance; one flexional, another logical.

We may express these facts differently, by saying that if the verb is in the plural number, its subject must be in the plural number; and if the subject is in the plural number, the verb must be in the plural number. In other words, both subject and verb take the same condition; and this is what we mean by stating that *the subject and the verb must agree.* In general, then, the rule is this:—

The subject and the verb must be in the same number and person; or, to state the same fact differently, *the subjects and their verb must agree in number and person.*

Nouns of multitude—that is, *nouns signifying many—take their verbs in the plural.*

When, however, the idea of *one* predominates—that is, when you regard the object spoken of *as a whole*, and not as consisting of parts—then a collective noun requires its verbs to be in the singular number: as—

The Parliament *was* dissolved; but
The people *were* admitted to the Queen's presence;

for the word *people* gives the idea of many persons.

Nouns are of the third person. But some grammarians have ascribed all the three persons to nouns. In only one form of construction, however—namely, the form that bears the name of *apposition*—can nouns have a first, a second, as well as a third person. For example:—

Nouns in the First Person.—It is *I*, your old friend.
Nouns in the Second Person.—*Thou*, the man of my heart.
Nouns in the Third Person.—*He*, the king of the Jews.

Two or more nouns, or a noun and a pronoun, are said to be in apposition when, being in the same number, person, and case, they refer to the same person or thing, and when the second is put in order to explain or add something in meaning to the first.

The essence of apposition is in the fact that a word or words are apposed (ad *to*, and pono, *I put*), with a view to explain, enlarge, or qualify a foregoing noun or pronoun.

Observe that in every case of apposition there are two parts, the apposed part, and the part to which the apposition is made. Thus, in the sentence, "Richard, the king, lost his crown," the king is the apposed part, and Richard is the part to which the apposition is made.

ADVERBS: SYNTAX OF THE PREDICATE COMPLETED.

In the following phrase—

The sick man drinks copiously,

copiously is the adverb of the proposition. Instead of an adverb we may have in the proposition an adverbial phrase: as—

The sick man drinks *with freedom.*

Whatever affects the affirmation of a sentence performs the office, and may be said to hold the place, of an adverb. Phrases which in some way affect the affirmation are numerous, as they vary with the variation of time, place, and manner: as—

Time.—The sick man { yesterday drank. / on falling sick drank.
Place.—The sick man { drank in his chamber. / drank in his bed.
Manner.—The sick man { drank with eagerness. / drank at one draught.

Position of the Adverb.—The ordinary place for the adverb is immediately before or after the verb. Euphony, as well as idiom, has an influence in determining the position of the adverb. Sometimes an adverb is placed before the verb in order to allow the verb and its object to stand together: as—

The sick man *copiously* drank water.

The position of some adverbs has much to do with the sense. There is a great difference between these two statements:—

Only the man went out.
The man *only went out.*

The first states that the man went out, and no one else; the second states that the man did nothing but go out.

Agreement of Adverbs.—Adverbs, though so called because they are put to verbs, qualify adjectives as well as verbs: as—

"Any passion that *habitually* discomposes our temper, or unfits us for *properly* discharging the duties of life, has *most certainly* gained a very dangerous ascendancy."—*Blair.*

Adjectives may also be said to qualify participles, but as the participle is only a part of the verb, a separate statement of the fact is hardly necessary.

There are elliptical forms which seem to make some adverbs independent of any verb. But the independence is only apparent. In reality every adverb on examination will be found to qualify an affirmation.

The words *yes* and *no* are exceptions. When you ask a child, "Do you love me?" and the child answers "Yes," the adverb *yes* is only an abbreviated form of the sentence *I do love you.*

No and *not* are often misused. *No* is the answer

to a question when no other answer is given: *not* is prefixed to the verb employed in giving the answer: as—

Are you ill? No.
Are you ill? I am not ill.

Hence in all sentences *not* should be used; consequently "whether or no" is wrong; it should be *whether or not*.

When *not* is prefixed to the verb, and so affects or negatives the whole affirmation, if a negative is required with a succeeding member, *or* should be used; but if the *not* (or *neither*) negatives only one word or one phrase, then with the succeeding or corresponding word or phrase employ *nor*: as—

For two months I could not think or speak.
He allowed me not to speak nor to write.
He gave me neither money nor clothes.

Observe that *neither* is properly used of two only, meaning *not either*—that is, not one of two. Hence it takes in the second clause *nor*.

PARTICIPLE.

Of the predicate in the sentence,

The man drinks a beverage made of wine and water,

the word *made*, the word *of*, and the word *and* remain to be studied.

These words might have stood in the subject. Their position in either the subject or the predicate is of no importance. The only thing of importance is to show that a simple sentence may embrace all the parts of speech; for thus you learn that, when you have mastered the syntax of a simple sentence, you have mastered the essential doctrines of English grammar.

The past participle *made* offers an instance of agreement and government united in one word; for *made* agrees with *beverage*, and together with *beverage* is governed by *drinks*. In general it may be stated that *participles admit of concord and dependence*.

As we have seen, a verbal noun identical in form with the present participle is used sometimes without, sometimes with a pronoun, also sometimes with and sometimes without an object: as—

"*Describing* a past event as present has a fine effect in language."—*Kames*.

Here the verbal noun is the subject of the sentence.

It may, however, be the object: as—

"Avoid *being* ostentatious and affected."—*Blair*.

As we have seen, the verbal noun may combine the constructions of verb and noun. The following is a good example:—

"Mr. Dryden makes a very handsome observation on *Ovid's writing a letter* from Dido to Æneas."—*Spectator*.

The construction in this last example deserves study: the preposition *on* governs *writing* as a noun; *writing* as a noun governs *Ovid's*, and *writing* as a verb governs *letter*.

After some verbs the verbal noun is found with peculiar frequency: as—

Verbs of Desisting.—"They have done *speaking*."—*Harris*.
Verbs of Omitting.—"He omits *giving* an account of them."—*Tooke*.
Verbs of Preventing.—"Our sex are prevented from *engaging* in these turbulent scenes."—*West*.
Verbs of Avoiding.—"He might have avoided *treating* of the origin of ideas."—*Tooke*.

SYNTAX OF THE PREDICATE: THE VERB—THE OBJECT.

We must now conduct you to the predicate of a simple proposition. In order to affect our purpose, we must modify the model sentence a little, as thus:—

SUBJECT.	PREDICATE.
The sick man	drinks a beverage made of wine and water.

The sentence thus altered brings under our notice two additional parts of speech—namely, the preposition (*of*) and the conjunction (*and*). It also directs our attention specifically to government—namely, in the relation borne by the verb *drinks* to the noun *beverage*, and in the relation borne by the preposition *of* to the noun *wine* and the noun *water*.

If now we look at our predicate, we find that it may be divided into two parts—namely, the verb and the object: as—

SUBJECT.	PREDICATE.	
	Verb.	*Object.*
The man	drinks	a beverage made of wine and water.

Viewed in relation to its several components, the predicate contains the verb *drinks*; the article *a*; the nouns *beverage*, *wine*, *water*; the past participle *made*; the preposition *of*; finally, the conjunction *and*. The articles have been already handled. The nouns, the verb, and the preposition range themselves under the general head of government; the past participle offers an instance of agreement; the conjunction acts merely in the way of combination.

GOVERNMENT—THE OBJECT AFTER A VERB.

Every transitive verb has an object, expressed or understood, and the same verb may sometimes be used transitively or intransitively. If no specific object is given, the verb may be considered intransitive: as—

Intransitive.—Man drinks;	the horse trots;
Transitive.—Man drinks *water*;	the horse trots *ten miles* an hour.

The verb *drinks* may be resolved into these terms, *is drinking*; as in this example:—

The sick man is *drinking* a beverage;

whence we learn that present participles have the same government as the verbs to which they belong.

Intransitive verbs, though in general incapable of an object, may take an object in a noun of kindred meaning: as—

"Let me *die the death* of the righteous." (Numb. xxiii. 10.)

Intransitives have the force of transitives also in certain idiomatic phrases: as—

"They laughed him to scorn." (Matt ix. 24.)

THE OBJECT.

The object of a proposition may, as we have seen, appear in a variety of forms. The object also assumes several shapes. The chief variations may be presented as follows:—

The object of a proposition may be either

1. *A Noun.*—The man drinks a *beverage*.
2. *A Pronoun.*—The man calls *me*.
3. *A Noun and an Infinitive.*—The man bids *his son remain.*
4. *Two Nouns.*—He teaches *his son Latin.*
5. *A Proposition.*—The man declares *he is ill.*

If dependent on the verb—that is, if it receives the action of the verb—the noun is the object of the verb: as—

"Prevailing *fame*, misfortune lends him *wings*,
And Pompey's self his own sad *story* brings."—*Rowe's "Lucan."*

Equally simple is the case of a pronoun viewed as the object of a verb: as—

"Did I request *thee*, Maker, from my clay,
To mould *me* man?"—*Milton.*

The construction of a noun and infinitive as the object of a verb may be slightly varied. For the noun a pronoun may be substituted: as—

The man bids *me* remain.

Before most verbs thus related the preposition *to* is placed, as in this example:—

The man commands his *son to remain.*

In this sentence it is clear that the words "his son to remain" form a compound object, and are in the same relation to the verb as the single noun *army* in the ensuing sentence:—

The man commands an *army.*

In the previous sentence, *son* is at once the object (or part of the object) to the verb *commands*, and the subject of the infinitive *to remain; son*, therefore, may be considered as the objective case before the infinitive *to remain.*

The object, "his son to remain," may be enlarged, thus:—

The man commands his son and *daughter* to remain.
The man commands his *only* son to remain.
The man commands his son *forthwith to go home and remain there.*

All these constructions, and others of a similar kind, hold to the verb the same relation that we have indicated—that is to say, they are severally the objects to the verb *commands*. These objects are compound, and being compound, they may be resolved into their component parts, and the relations set forth which those parts bear to each other, as well as that which they bear to their common head, the verb *commands.*

Instead of the second object, a noun might be given, as—

The man teaches his son Greek.

Here the noun *Greek* (that is, the Greek language) holds to *teaches* the relation which *to remain* holds to *commands*. It is not every verb, however, which has after it two nouns as objects. But as in Latin, so in English, verbs which signify *to learn* and *to teach* may have dependent on them two separate objects.

In some instances where two objects appear after a verb, the construction is in reality elliptical; for example—

He gave his son a book;

that is, in full—

He gave a book *to* his son.

You will now have the less difficulty in understanding how a sentence may be the object of a verb: as—

The man says (that) *he is ill.*

The words *he is ill* you will at once recognise as a sentence or statement, and a little reflection will show you that the sentence bears to the verb *says* the relation of an object to its verb. The conjunction *that* is merely an explanatory word, which joins the two statements.

A sentence as the object of the verb may also be enlarged:—

The man says he is sick *and likely to die.*
The man says he is sick, *and has been given over by the faculty for a long time.*

The compound object in our model sentence will now be readily understood, namely—

The man drinks *a beverage made of wine and water.*

In this compound object, which consists of the words in italics, analysis shows us a noun, *beverage*, depending on the verb *drinks*: a participle, *made*, agreeing with *beverage*, and therefore conjointly with *beverage* dependent on *drinks*; a preposition, *of*, connecting *made* with *wine* and *water*; a noun, *water*, dependent on the preposition *of*; a conjunction, *and*, connecting *water* with *wine*; and, finally, another noun, *wine*, connected with *water* and the preposition *of*, and consequently standing to the preposition *of* and to the sentence generally in the relation held by the noun *water.*

We must add a few words respecting the object.

Observe, then, that *wine* and *water* do not hold to *drink* exactly the same relation which the words "his son Greek" hold in the above example. If so, a verb might be said to have several objects, for example —

The man bequeathed *money, wine, books, and land.*

It is true that the nouns form the object to the verb *bequeathed*, but they are a compound object made by *repetition*; whereas in the proposition

The man taught his son Greek,

the compound object is formed by *addition*. And in the construction which assigns to certain verbs a double object, one of those objects is a person, the other is a thing. Double objects, like single ones, may be augmented by repetition: as—

The man taught his wife, his sons, and his daughters Greek.
The man taught his son Greek, Latin, German, and French.

The position of the object is after the verb. And the observance of this law is in English so imperative that by disregarding it you create ambiguity, if you do not change the object into the subject and the subject into the object: as—

SUBJECT.		OBJECT.	SUBJECT.		OBJECT.
The father	struck	the son.	The son	struck	the father.

As an instance of ambiguity from the inversion of the object, take this instance:—

"This *power* has *praise* that virtue scarce can warm,
Till fame supplies the universal charm."—*Johnson.*

Which is the subject, and which the object? Do you mean that *power* has *praise*, or that *praise* has *power*?

PLANE TRIGONOMETRY.—I.

INTRODUCTION—CIRCULAR MEASURE OF ANGLES—FUNCTIONS OF ANGLES—RELATIONS OF TRIGONOMETRICAL RATIOS TO ONE ANOTHER.

TRIGONOMETRY is derived from two Greek words, τριγωνον (tri-go'-non), a *triangle*, and μετρεω (met'-re-o), *I measure*. Its meaning would thus appear to be the science of *computing triangles*, and its scope somewhat akin to Geometry. Geometry enables us, certain sides and angles of a triangle being given, to *construct* or draw the visible triangle to which they belong; while Trigonometry tells us how to *calculate* the parts or area of a triangle when the numerical values of certain of its sides or angles, or even the numerical value of the ratios they bear to one another, are known to us. Trigonometry is used in the practical arts of surveying and navigation; and the power of computing triangles—and by that means many other figures, since all figures bounded by straight lines may be split up into triangles—is very useful. A moderate study of the science is enough for these purposes—that is to say, will establish a sufficient number of formulæ to enable us, with the aid of a book of tables, to calculate the elements of any triangle when sufficient data are given. It will also enable us to solve many mathematical problems, for the formulæ and equations of Trigonometry are extensively used in calculations not relating to angles or triangles at all.

Trigonometry is divided into Plane and Spherical Trigonometry, the latter of which treats of triangles drawn upon spherical surfaces, and is comparatively special in its application. We are at present only concerned with Plane Trigonometry.

It is presumed that the learner is acquainted with the ordinary or *sexagesimal* method of measuring angles, according to which the circumference of every circle is considered as divided into 360 equal parts, called *degrees*, each degree being divided into 60 *minutes*, and each minute into 60 *seconds*, the signs for which are respectively ° ′ ″. The fourth part of the circumference, or 90°, is called a quadrant, and subtends a right angle at the centre. A right angle is thus described as 90°, and every angle is measured by the number of degrees, minutes, and seconds in the arc or portion of the circumference which subtends or lies opposite to it.

I. *Circular Measure of Angles.*—Trigonometry, it has been before observed, is, in its primary signification, the science which deals with the relations existing between the sides and angles of triangles. But to enable us to deal freely with such utterly dissimilar expressions as *lines* and *angles* in combination with each other, it is necessary to bring them—to speak figuratively—"to the same denomination;" and a system called *circular measure* has been devised by which any angle may be described (or, in other words, its size expressed) by a statement of the ratio existing between two lines, both of which are known, and both of which may be obtained without difficulty for any given angle. The unit by which all angles are measured on this system is *that angle whose subtending arc is equal in length to the radius*, and is called the *circular unit*, as the angle ACU in Fig. 1, where arc AU = radius AC.

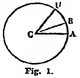


Fig. 1.

To express any other angle, ACB, in terms of the circular unit:—Let A be the value sought, a the subtending arc, and r the radius. By Euclid VI. 33—

ACB : ACU :: arc AB : arc AU;

but ACU is the unit, or 1, and arc AU = radius.

Therefore $A : 1 :: a : r$,

$$\text{or } A = \frac{a}{r} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

That is to say, the size or value of an angle may be expressed in circular measure by the ratio subsisting between the arc and the radius, or more specifically *by dividing the arc by the radius.* We have thus found means to express the size of an angle by the relation between the length of two lines.

By a calculation based upon the more abstruse results of the science, it has been ascertained approximately that the circumference of a circle = the diameter × 3·14159.. This number occurs so frequently, that it is the custom to represent it by a symbol—the Greek letter π (pronounced *pi*). As diameter = twice radius, we have—

$$\text{Circumference} = 2\pi r. \ldots\ldots\ldots\ldots \quad (2)$$

$$\text{Whence the arc subtending a right angle} = \frac{\pi r}{2}. \quad (3)$$

since a right angle is subtended by a quadrant, or one-fourth of the circumference.

Let any angle of A° be subtended by an arc, a: then, by the last formula, and by Euclid VI. 33, before quoted—

$$A^\circ : 90^\circ :: a : \frac{\pi r}{2}. \qquad \text{Whence } \frac{A^\circ}{90^\circ} = \frac{a}{\frac{\pi r}{2}} = a \cdot \frac{2}{\pi r}.$$

$$\text{Multiplying by } 90^\circ,\ A^\circ = \frac{180^\circ}{\pi} \cdot \frac{a}{r}. \ \ldots\ldots \ (4)$$

From this either arc, radius, or angle (in common measure) may be found when the other two are given. Thus: To what radius is an arc of 10 feet drawn which subtends an angle of 12°?

$$\text{By (4) } 12^\circ = \frac{180^\circ}{3\cdot14159} \cdot \frac{10}{r}.$$

Whence—

$$12r = \frac{180}{3\cdot14159} \times 10, \text{ and } r = \frac{1800}{3\cdot14159 \times 12} = 47\cdot74 \text{ ft.}$$

To express the circular unit in sexagesimal measure:—

By (4), since in this case $a = r$,

$$\text{Circular unit} = \frac{180^\circ}{\pi} \times \frac{r}{r} = \frac{180^\circ}{3\cdot14159} = 57\cdot29578^\circ$$
$$(= 206{,}265'').$$

Substituting $\frac{\pi r}{2}$ [see (3)] for a in (1), we get—

$$\text{Circular measure of right angle} = \frac{\pi}{2}.$$

II. "*Functions*" *of an Angle.*—Although circular measure gives us one means of describing or measuring an angle by lines only, there are other more convenient lines pertaining to every angle than the arc and radius above referred to. They are found by constructing (according to directions given hereafter) a certain simple geometrical figure, the chief parts of which are the angle (which we will call A) and a circle. The lines so produced bear varying ratios to each other as the angle A varies in size; *consequently their ratios form measures of the angle.* These lines—or, more properly, their ratios to the radius to which the circle is drawn—are called "functions of the angle," and their ratios to the radius, for any *given* angle, are always the same, whatever be the length of the radius..

The practical utility of this system of lines or "functions" lies in the fact that the figure includes a right-angled triangle, of which the angle A forms part, and that all the functional lines before mentioned either are or may be represented by sides of this triangle. The scale to which the figure is drawn (dependent on the radius adopted for the circle) does not alter the shape of the triangle, or, consequently, the angle-measuring ratios (as we may style them) which exist between its sides. In short, we have now the means of describing (or measuring) every angle which forms part of a right-angled triangle *in terms of the sides*, an enormous practical convenience, upon which the whole science of Trigonometry is based; for it must be remembered that all plane rectilineal figures which require to be calculated may be split up into such triangles, and thus dealt with in detail.

To explain the foregoing:—Let the angle be D A B in Fig. 2, of less than 90°. Placing one limb, A D, in a horizontal position, take any length A D or A B as a radius, and describe the circle D B O. From the extremity of one radius, A B, let fall the perpendicular, B C, upon the other.

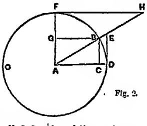


Fig. 2.

B C is called the *sine* of the angle B A D to the radius chosen (A B in this case). At the extremity of the radius A D draw the perpendicular D E, to meet the other radius (produced). D E is called the *tangent*, and A E the *secant* of the angle D A B, to the radius chosen.

The difference between an acute angle and a right angle is called its *complement* (*i.e.*, the angle lacking to complete or fill up the right angle); thus, the complement of D A B is clearly B A F. A slight inspection of the figure shows that B G holds the same relation to B A F that B C holds to D A B; B G is therefore the sine of B A F, F H its tangent, and A H its secant. Now the function of any angle

is said to be the co-function of its complement; thus, BG is the *cosine*, FH the *cotangent*, and AH the *cosecant* of DAB, just as the three lines described in the last paragraph are respectively the cosine, cotangent, and cosecant of BAF. It is not, however, usual to speak of "co-functions"; all six of the lines described above (or, rather, their ratios to the radius) are called functions of DAB. Two others, not of much utility, are sometimes introduced—viz., CD, *the versed sine*, and the corresponding line GF, the *coversed sine* of DAB.

We will now express the above functions of BAC in terms of the sides of the triangle ACB. The functions are *the ratios borne by certain lines to the radius* in the figure just described; and as a ratio or proportion may always be expressed in the form of a fraction, the functions may be obtained *by dividing these lines by the radius.* $\frac{BC}{AB}$ is therefore a correct expression of the value of the sine of BAC, AB being a radius. AB, AD, and AF, being all radii, are equal and interchangeable. So are BG and BC. Moreover, the triangles AFH, EDA, and ACB are evidently equiangular, and therefore, by Euclid VI. 4, the same ratios exist between their corresponding sides; for instance, FH : AF : : AC : CB, or $\frac{FH}{AF} = \frac{AC}{CB}$. Bearing these considerations in mind, and putting A for the angle BAC, and using the common abbreviations, we get the following list:—

$$\sin. A = \frac{BC}{AB}. \qquad \cot. A = \frac{FH}{AF} = \frac{AC}{BC}.$$

$$\cos. A = \frac{BG}{AB} = \frac{AC}{AB}. \qquad \sec. A = \frac{AE}{AD} = \frac{AB}{AC}.$$

$$\tan. A = \frac{DE}{AD} = \frac{BC}{AC}. \qquad \text{cosec.} A = \frac{AH}{AF} = \frac{AB}{BC}.$$

$$\text{Moreover, vers.} A = \frac{DC}{AB} = \frac{AD - AC}{AB} = \frac{AB - AC}{AB}$$

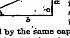
$$= 1 - \frac{AC}{AB} = 1 - \cos. A \text{ .... } (5)$$

$$\text{And coverS.} A = \frac{FG}{AB} = \frac{AF - AG}{AB} = \frac{AB - BC}{AB}$$

$$= 1 - \frac{BC}{AB} = 1 - \sin. A \text{ .... } (6)$$

Fig. 2 having served its purpose of giving a *raison d'être* for this list, and some explanation of the otherwise meaningless names of the functions, may now be laid aside. The right-angled triangle, which is its one claim to notice, reappears in a permanent form in Fig. 3, with its angles indicated by the same capitals as before, and its sides by *italics*, *a* being the side opposite to A, and so on.

Fig. 3.



C being the right angle, *c* is the *hypothenuse*, and *b* is "the side adjacent to the angle." The angle B is the *complement of* A, since the two acute angles in a right-angled triangle must always equal one right angle (for all the angles of *every* triangle = *two* right angles).

To suit the altered lettering, we append a new list of functions:—

$$\sin. A = \frac{a}{c}. \qquad \tan. A = \frac{a}{b}. \qquad \sec. A = \frac{c}{b}.$$

$$\cos. A = \frac{b}{c}. \qquad \cot. A = \frac{b}{a}. \qquad \text{cosec.} A = \frac{c}{a}.$$

It is plain that, if we know the numerical value of any one of these ratios, we can find A. In other words, if the ratio between any two sides of a right-angled triangle be given, we can define all the angles. By means which cannot yet be explained, a table of ratios for all angles (in degrees and minutes) under 90° has been drawn up, by reference to which the angle corresponding to any given ratio can be identified at once. This is called the table of *natural sines and cosines*, and from it all other functions can be readily obtained by means of the equations in the next section. Tables have also been computed of *the logarithms* of these numerical values, including every function of all the angles just mentioned. By substituting the logarithmic values for the natural or actual values of the ratios, the processes of calculation are immensely facilitated, just as lengthy calculations of natural numbers are often solved with little trouble by the aid of their logarithms. In the next lesson we shall find the natural sines, etc., of two or three angles which can be solved geometrically; but, as stated above, the solution in most cases rests upon other and more abstruse grounds.

III. *Relations of Trigonometrical Ratios to one another.*—Since the square of the hypothenuse of a right-angled triangle = the squares of the other two sides (Euclid I. 47), we have, by Fig. 3—

$$a^2 + b^2 = c^2.$$

$$\text{Dividing by } c^2, \ \frac{a^2}{c^2} + \frac{b^2}{c^2} = \frac{c^2}{c^2}; \ i.e., \left(\frac{a}{c}\right)^2 + \left(\frac{b}{c}\right)^2 = 1;$$

$$\text{or, } \sin.^2 A + \cos.^2 A = 1 \text{ .... } (7)$$

Dividing the first equation by b^2, we get—

$$\left(\frac{a}{b}\right)^2 + 1 = \left(\frac{c}{b}\right)^2;$$

$$\text{or, reversing the order, } \sec.^2 A = 1 + \tan.^2 A. \quad (8)$$

$$\text{Dividing the same by } a^2, \text{ we get } 1 + \left(\frac{b}{a}\right)^2 = \left(\frac{c}{a}\right)^2;$$

$$\text{or, reversing as before, cosec.}^2 A = 1 + \cot.^2 A. \quad (9)$$

$$\text{Since } \frac{a}{b} \cdot \frac{b}{a} = 1, \quad \tan. A \cdot \cot. A = 1. \text{ ...... } (10)$$

Again, $\tan. A = \frac{a}{b} = \frac{\frac{a}{c}}{\frac{b}{c}}$, $\therefore \tan. A = \frac{\sin. A}{\cos. A}$. .... (11)

Again, $\cot. A = \frac{b}{a} = \frac{1}{\frac{a}{b}}$, $\therefore \cot. A = \frac{1}{\tan. A}$. .... (12)

Again, $\cot. A = \frac{b}{a} = \frac{\frac{b}{c}}{\frac{a}{c}}$, $\therefore \cot. A = \frac{\cos. A}{\sin. A}$. .... (13)

Again, $\sec. A = \frac{c}{b} = \frac{1}{\frac{b}{c}}$, $\therefore \sec. A = \frac{1}{\cos. A}$. .... (14)

Again, $\operatorname{cosec}. A = \frac{c}{a} = \frac{1}{\frac{a}{c}}$, $\therefore \operatorname{cosec}. A = \frac{1}{\sin. A}$. (15)

From these equations (7) to (15), we can find the value of any function in terms of any other function, as in the following examples:—

It has already been shown in (5) and (6), that

$$\text{vers. } A = 1 - \cos. A.$$
$$\text{covers. } A = 1 - \sin. A.$$

To show sin. A *in terms of cos.* A, *and vice versâ:*

From (7) we get $\sin.^2 A = 1 - \cos.^2 A$.

$$\therefore \sin. A = \sqrt{1 - \cos.^2 A}. \text{ .... (16)}$$

And similarly, $\cos. A = \sqrt{1 - \sin.^2 A}$ ... (17)

Cot. in terms of sin.—By (13) and (17),

$$\cot. A = \frac{\cos. A}{\sin. A} = \frac{\sqrt{1 - \sin.^2 A}}{\sin. A} \text{ ...... (18)}$$

Cos. in terms of tan.—By (14), $\cos. A = \frac{1}{\sec. A}$;

whence, by (8), $\cos. A = \frac{1}{\sqrt{1 + \tan.^2 A}}$ (19)

Cosec. in terms of sec.—Using consecutively (15), (16), and (14),

$$\operatorname{cosec}. A = \frac{1}{\sin. A} = \frac{1}{\sqrt{1 - \cos.^2 A}} = \frac{1}{\sqrt{1 - \frac{1}{\sec.^2 A}}}.$$

$$= \frac{1}{\frac{\sqrt{\sec.^2 A - 1}}{\sec.^2 A}} = \frac{1}{\frac{\sqrt{\sec.^2 A - 1}}{\sec. A}}.$$

$$\therefore \operatorname{cosec}. A = \frac{\sec. A}{\sqrt{\sec.^2 A - 1}} \text{ .... (20)}$$

Sin. in terms of tan.—By (11) and then (19),

$$\sin. A = \tan. A \cos. A. = \tan A \cdot \frac{1}{\sqrt{1 + \tan.^2 A}}.$$

$$\therefore \sin. A = \frac{\tan. A}{\sqrt{1 + \tan.^2 A}}. \text{ .... (21)}$$

Other important results are—

From (8), $\tan. A = \sqrt{\sec.^2 A - 1}$. ...... (22)

$\sec. A = \sqrt{1 + \tan.^2 A}$. ...... (23)

From (9) $\cot. A = \sqrt{\operatorname{cosec}.^2 A - 1}$. ... (24)

$\therefore \operatorname{cosec}. A = \sqrt{1 + \cot.^2 A}$. ...... (25)

The learner should take the trouble to express *every* function in terms of every other function, writing down both reasoning and results in each case, and will thus acquire a great and most useful familiarity with the ratios existing between the various functions. Only the plain rules for solving simple equations are required for this.

EXERCISE 1.

1. If tan. A = 0·8, calculate sin. A (say to four places of decimals).

   By (21) $\sin. A = \frac{\tan. A}{\sqrt{1 + \tan^2 A}} = \frac{\cdot 8}{\sqrt{1 + \cdot 64}} = \frac{\cdot 8}{\sqrt{1 \cdot 64}}$

   $= \frac{\cdot 8}{1 \cdot 2806} =$ [illegible]

2. If cos. A = 0·45, calculate sin. A.
3. If tan. A = 0·22, calculate cos. A.
4. What is the value of sin. A when cosec. A = 1·25?
5. Calculate cot. A on the assumption that tan. A = $\frac{1}{2}$.
6. If versin. A = $\frac{1}{2}$, calculate all the other functions of A.
7. Show that cosec. A − sin. A = cos. A cotan A.
8. Show that $\frac{1 + \cos. A}{\sin.^2 A} = \frac{1}{1 - \cos. A}$.

COMPLEMENTAL ANGLES—SUPPLEMENTAL ANGLES—TRIGONOMETRICAL CONCEPTION OF AN ANGLE—NEGATIVE ANGLES.

IV. *Complemental Angles.*—It was explained in Section II. that the *complement* of an angle (*i.e.*, of an acute angle) is the difference between it and a right angle, or, in other words, its *defect from* a right angle; and it was stated that the function of an angle is the co-function of its complement—that is,

$$\sin. A = \cos. (90^\circ - A).$$
$$\cos. A = \sin. (90^\circ - A); \text{ and so on.}$$

Or, in circular measure,

$$\left.\begin{array}{l} \sin. A = \cos. \left(\frac{\pi}{2} - A\right) \\ \cos. A = \sin. \left(\frac{\pi}{2} - A\right) \end{array}\right\} \text{ .... (26)}$$

This is perhaps apparent enough by inspection of Fig. 2, but Fig. 3 shows it more clearly. The complement of A in that is B, and it is plain that, just as cos. A is $\frac{b}{c}$, so cos. B is $\frac{a}{c}$, since a is the adjacent side to B. But $\frac{a}{c} = \sin. A$.

$$\left.\begin{array}{l} \therefore \sin. A = \cos. B \\ \cos. A = \sin. B \end{array}\right\} \text{ .... (27)}$$

And so on for other functions.

The above may, however, be thus proved geometrically:—

In Fig. 4, let $CAB = A$; then $BAF = \frac{\pi}{2} - A$. Make $GAF = CAB$ (whence $CAG = BAF$). Note that $AB = AG =$ radius.

AGH and BAD are easily shown to be similar triangles, whence,

$$\left.\begin{array}{c} BD : AB :: AH : AG \\ \text{and} \\ AD : AB :: GH : AG \end{array}\right\} \text{whence} \left\{\begin{array}{l} \frac{BD}{r} = \frac{AH}{r}, \\ \frac{AD}{r} = \frac{GH}{r}. \end{array}\right.$$

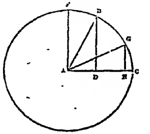


Fig 4.

$$\therefore \left.\begin{array}{c} \sin. CAB = \cos. CAG \\ \text{and} \\ \cos. CAB = \sin. CAG \end{array}\right\} \begin{array}{l} \text{But } CAB = A, \\ \text{and } CAG = \frac{\pi}{2} - A; \end{array}$$

$$\left.\begin{array}{l} \therefore \sin. A = \cos. \left(\frac{\pi}{2} - A\right) \\ \quad \cos. A = \sin. \left(\frac{\pi}{2} - A\right). \end{array}\right\} \therefore \text{as at (26)}$$

ELECTRICITY.—VII.

[Continued from p. 149.]

GALVANOMETERS.

THE TANGENT GALVANOMETER AND ITS SCALE—MEASUREMENT OF CURRENT BY IT — THE ASTATIC NEEDLE — THOMSON'S REFLECTING GALVANOMETER.

If we know the E.M.F. that is driving a steady current through any circuit, and also know the resistance of that circuit, we can calculate the strength of the current. Under ordinary circumstances we do not know the exact E.M.F., neither do we know the exact resistance, and some simple method of ascertaining the strength of the current is therefore desirable. It was stated in lesson I. that an electric current has three effects, a heating, a chemical, and a magnetic, and it was shown in detail how its strength could be determined by its chemical effect; it can also be determined—and in a much simpler manner—by its magnetic effect.

A current flowing through any conductor exerts a force on every magnet placed in its vicinity, and if a magnet be pivoted, or suspended, so as to be capable of motion it will be deflected through a certain angle. The direction in which the deflection will take place is governed by a definite law. Considering the apparatus illustrated in Fig. 27, S N is a horizontal wire through which a current can be sent, and a b is a pivoted magnetic needle of which a is the north pole and b the south, and which is placed immediately beneath the wire. The needle—when no current is flowing—points magnetic north and south, and the wire is arranged so as to point in the same direction. If a current be now sent through the wire, entering it at the point S and leaving it at the point N, as is indicated by the arrows, the needle will be immediately deflected, and will take up the position shown in the figure. If the current be sent through the wire in the opposite direction, the needle will be deflected through exactly the same angle, but in the opposite direction; if the needle be placed above the wire instead of below it, the deflections would be in the opposite directions. From this it can be seen that if two wires carrying currents in opposite directions be placed, one above and the other below the needle, both wires will tend to deflect it in the same direction. The law for the direction of deflection is best remembered thus: *imagine yourself swimming in the direction of the wire and looking at the needle, and that the current enters at your feet and leaves at your head; then the north pole of the needle will be deflected to the left.*

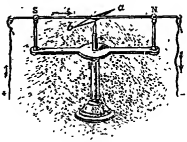


Fig. 27.

The same rule applies whether the wire passes under or over the needle; so that, if a wire having passed over the needle be doubled back so as to pass under it, both portions of the wire will tend to deflect the needle in the same direction; in fact, if the wire be wrapped round and round the needle so that each convolution is in the same or a parallel

plane to it, then each portion of the wire tends to deflect the needle in the same direction.

The amount of the deflection depends upon the number of times the wire passes under and over the needle, and upon the strength of the current. It is a very prevalent idea amongst beginners that the deflection also depends in some way upon the strength of the magnetic needle. This idea is quite wrong; whether the needle be strongly magnetised or not, the deflection will be exactly the same. The strength of the needle, however, has some bearing on its behaviour; if it be strongly magnetised, it will swing rapidly on the application of the current, and come to its permanent position soon, whereas if it be feebly magnetised, its motion will be slow and sluggish, but its final position will be the same in each case.

A combination of a coil of wire and a pivoted magnetic needle, such as has been described, is called a Galvanometer, and the deflection of the needle not only indicates the presence of a current, but also gives a measure of its strength. The deflection of any ordinary galvanometer is not proportional to the strength of the current passing through the instrument. If the deflections are very small—say, below 8 or 10 degrees—they are nearly proportional to the currents that produce them, but for larger deflections the approximate proportionality ceases to exist, and the higher the reading the more marked is this want of proportionality. The reason of this is that the motion of the needle carries its poles out of the direct influence of the coil, and though the force exerted by the coil is exactly proportional to the current passing through it, still this force acts only in an oblique direction on the needle, and therefore has not the same effect as it would have if the poles of the needle were at, or near, their original positions.

To construct a galvanometer which will give proportional readings over a large portion of its scale is a difficult though not impossible operation; but to construct one in which the currents passing are proportional to the tangents of the angles through which the needle turns, is a very simple task; such a galvanometer is illustrated in Fig. 28—it is known as a tangent galvanometer.

The Tangent Galvanometer.—The coil *r r* is made up in circular form as shown, and may consist of any number of turns of wire according to the strengths of currents it is required to measure; if for strong currents, only a few turns of thick wire should be used, but if for feeble currents, it should contain many turns of fine wire. The magnetic needle is placed at the centre of the coil as shown, and its length should be very small compared with the diameter of the coil. In Fig. 28 the needle is suspended by the single cocoon fibre *f*. When about to be used, the coil should be set vertical by means of the levelling screws, *s s s*, on the feet of the instrument, and its plane should be in the same direction as the needle. When these conditions are fulfilled, the current passing through the coil is proportional to the tangent of the angle through which the needle turns. The shape of

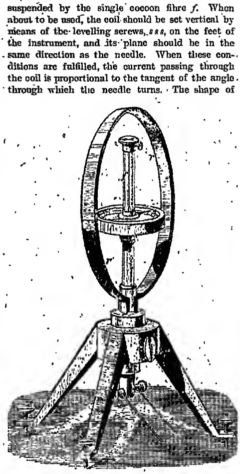


Fig. 28.—The Tangent Galvanometer.

the coil has some effect on the deflection, though it is not of great importance, except when great accuracy is desired. When the coil consists of many turns of wire, a certain ratio exists between its breadth and its depth which gives the best results; this ratio is eleven turns in the depth for every nine in breadth, or the depth of the coil should be to its breadth as 11 to 9.

As the needle is very small its motion cannot be easily measured directly; in order to overcome this difficulty, it is usual to attach at right angles to it a long pointer which can move over a graduated scale, and which thus magnifies the motion of the needle and renders it easy to read the deflection

accurately. The pointer should be made of aluminium, or better still should consist of a light glass fibre. It is useful to have a mirror under the pointer in order to avoid parallax in reading the deflections. The scale may be graduated in degrees, in which case the tangent of the deflection is proportional to the current; but it may also be graduated so that the readings themselves are proportional to the current. The manner in which the scale should be divided is shown in Fig. 29. Let P R be the scale that requires graduating in tangents; then at the point P draw the line P Q tangent to the circle, and divide it into any convenient

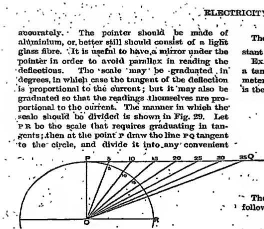


Fig. 29.

number of equal points as shown; join each of these points to the centre of the circle O, and mark the points where they cut the scale P R; these points on the scale will then denote proportional amounts of current. Starting with a current which will deflect the pointer to the point marked 5, twice that current will deflect it to 10, three times that current to the point 15, and so on. It will be noticed that the divisions get smaller and smaller as the deflection increases, showing that the coil produces less and less effect on the needle as it is deflected out of the plane of the coil. In order to completely graduate the scale, many more points should be taken than are shown in Fig. 29, and they should be taken closer together.

By means of a tangent galvanometer it is possible to measure a current absolutely if we know the dimensions of the coil; thus—

$$C = \frac{r}{20\pi n} H \tan. D,$$

where C expresses the current in ampères,
- " r " " radius of the coil in centimetres,
- " n " " number of turns of wire on coil,
- " D " " deflection of pointer in degrees,
- " π " " 3·1416,
- " H " " horizontal component of the earth's magnetic force. It is a slightly varying quantity, but may be taken approximately as 0·18 in London.

The quantity $\frac{r}{20\pi n}$ is usually known as the constant of the instrument.

EXAMPLE 1.—A deflection of 35° is produced on a tangent galvanometer whose radius is 10 centimeters, and which contain 99 turns of wire. What is the strength of the current?

Here $r = 10$,
" $H = 0·18$,
" $\tan. D = \tan. 35^{\circ} = 0·7002$,
" $\pi = 3·1416$,
and $n = 99$.

Substituting these values in the above formula we get

$$C = \frac{10}{20 \times 3·1416 \times 99} \times 0·18 \times 0·7002$$
$$= 0·000255 \text{ ampere.}$$ *Answer.*

The above formula can also be written in the following form—

$$\tan. D = \frac{20\pi n C}{H r},$$

but for small angles the tangent is proportional to the angle itself, and therefore we can also write the formula as follows:—

$$D = \frac{20\pi n C}{H r};$$

that is to say, the deflection is proportional to the strength of current passing through the coil, to the number of turns of wire on the coil, and is inversely proportional to the radius of the coil. In order, therefore, to get the largest possible deflection for a given strength of current—or, in other words, to make the galvanometer as sensitive as possible—the coil should be made as small as possible, but should contain as many turns of wire as possible. As the coil must be wound on a bobbin, which may consist of wood, ebonite, or brass, and as sufficient space must be allowed within the bobbin for the free motion of the magnet, there are clearly structural difficulties which prevent the coil from being very small. By using two coils, however, and a peculiar form of magnetic needle, the sensitiveness of the galvanometer can be much increased; this arrangement is shown in diagram in Fig. 30. The needle here is compound, consisting as it does of two strongly magnetised needles of equal length, S N and S′ N′. These

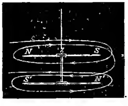


Fig. 30.—Astatic Needle.

needles are of nearly equal strength; they are fastened about their centres to a light vertical rod —usually consisting of aluminium—and are so fastened that their like poles point in opposite directions. If the two needles are of equal length and strength, and if the poles of S N be vertically above those of S′ N′, then the two needles neutralise each other, and the compound needle will take up and retain any position in which it is placed; it will clearly have no more tendency to point north and south than any other direction. Such a compound needle is called a *perfectly astatic needle.* It is, however, impossible to construct a combination which will be perfectly astatic, nor is it desirable for ordinary work. The usual astatic needle is one in which one of the needles is either

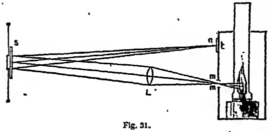


Fig. 31.

longer or stronger that the other, and which will therefore point north and south; such is the astatic needle shown in Fig. 30, and which is suspended by a single cocoon fibre.

The galvanometer contains two coils, a needle being placed in each. In Fig. 30 each coil is indicated by a single turn of wire, the direction of the current being shown by the arrow heads. It will be seen that the coils are so arranged that the current passes in opposite directions through them, and therefore that it will move both needles in the same direction, thus obtaining a much larger deflection than could have been obtained by the use of a single coil and a single needle. An astatic needle cannot of course be used in a tangent galvanometer, which essentially consists of a single coil with a small needle at its centre, but for most other galvanometers it can be used with advantage.

It is highly desirable that a galvanometer should give a deflection proportional to the current which is passing through it; nearly all galvanometers do this for very small deflections, and for those only. The difficulty then is to read those very small deflections accurately. A long, light pointer attached to the needle affords some help in the difficulty, but the length of the pointer that can be attached to a small needle is not great. The complete solution of the problem is due to Sir William Thomson, who attaching a small mirror to the needle, threw a beam of light on the mirror which reflected it on to a graduated scale conveniently placed. The effect of this arrangement is exactly the same as if a weightless pointer were attached to the needle, whose length was twice the distance between the mirror and the scale. As the usual distance between the mirror and scale is from three to ten feet, the length of the pointer should then be from six to twenty feet, and it should be weightless.

The principle of this arrangement is shown in Fig. 31. The beam of light from the lamp passes through a small hole *m m*, and then through the small lens L, which renders the rays parallel, in which state it falls on the mirror S—which is attached to the needle—and is reflected on to the graduated scale *a*. The general arrangement of the light and scale is more clearly seen in Figs. 32 and 33. The best arrangement is to have the hole through which the light passes circular, and to insert in it a convex lens of about five inches focal length. In front of which a fine wire is stretched vertically. The mirror should be concave, and the distance between it and the scale should be equal to half the focal length of the mirror. By this means a round spot of light is thrown on the scale with a distinct image of the line across it. For convenience in reading the deflection of the spot of light on the scale, the use of a round hole with a wire stretched across it—as is shown in Fig. 32—is very advantageous, and for the following reason: The room in which the work is carried on must of necessity be partially darkened, in which case it is impossible to distinguish the divisions on the scale if the scale is in any way finely divided. Under these circumstances the round spot of light illuminates that portion of the scale where the reading is to be taken, and the dark line across it marks the exact spot. If on the other hand the light had passed through a thin slit—as is often the case—the scale would not be quite visible, and much difficulty would be experienced in determining the exact position of the streak of light.

In Fig. 32 the lamp is placed in a kind of box, the door of which is shown open; this is to prevent the direct rays from the lamp from falling on and illuminating the whole of the scale. This box is, however, unnecessary, as the arrangement shown in Fig. 33 is equally effective. In Figs. 32 and 33 the scale is made of cardboard, with the divisions printed on, so that in order to take a reading, the

scale must be looked at direct : but in some situations it is far more convenient to take the readings from behind the scale, in which case the scale should be made of ground glass, celluloid, or some such semi-transparent material through which the spot of light as well as the line across it can be distinctly seen.

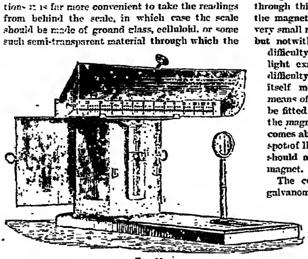


Fig. 32.

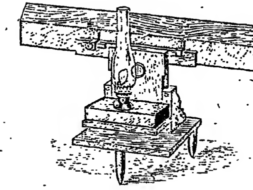


Fig. 33.

It is clear that with such an arrangement of mirror and scale, the slightest motion of the needle and mirror will occasion the spot of light to move over a large portion of the scale. The spot of light is brought to the zero on the scale by moving a magnet which is attached to the galvanometer, and by means of which the needle can be moved into any position. The turning of this magnet by the hand necessarily imparts a certain amount of vibratory motion to the needle, with the result that the spot of light takes some time to settle down to its final position, and much delay is often occasioned through this cause. There is usually attached to the magnet a tangent screw, by means of which very small motions can be imparted to the magnet, but notwithstanding this, there is always some difficulty experienced in bringing the spot of light exactly to the zero on the scale. This difficulty can be overcome by making the scale itself movable in a horizontal direction by means of a rack and pinion. Every scale should be fitted up with some such arrangement, and the magnet should never be moved unless it becomes absolutely necessary to do so. Where the spot of light is anywhere near the zero, the scale should always be moved in preference to the magnet.

The construction of a Thomson reflecting galvanometer is clearly shown in Fig. 34.

On a horizontal ebonite base stand four circular vertical ebonite pillars P P, *p p* : two of these P and P are used for supporting the coils and the needle. The tangent galvanometer contains but one coil and one suspended magnet, but reflecting galvanometers usually contain four coils and two magnets. These coils are placed in pairs, so that looking at the instrument, it has the appearance of containing but two coils ; the reason of this arrangement is that each needle shall hang as nearly as possible between two pairs of coils, which can therefore exert their greatest effect on the needles. Two of these coils B and B are wound in ebonite boxes which are hinged, and capable of being opened as shown in the figure for the purpose of suspending the needle when it becomes necessary to do so. (It may here be mentioned that these galvanometers are often constructed with all coils fixed in ebonite boxes so that they can be removed, and replaced by others of the same size, but containing either a greater number of turns of finer wire, or a smaller number of turns of thicker wire, in order to adapt the galvanometer to the particular kind of work for which it is being used.)

The needle is astatic, and usually consists of eight small strong magnets. Four of these magnets—with their poles turned in the same direction—are placed between the upper pair of coils, whilst the other four—with their poles all pointing in the opposite direction—are all placed between the lower pair of coils. These eight magnets are rigidly attached to a light thin vane S S, which may consist either of aluminium or of mica This vane is suspended by a single silk fibre to the

screw *n*, which can be raised or lowered by a nut, but which does not turn during the process of being raised or lowered; this absence of turning prevents

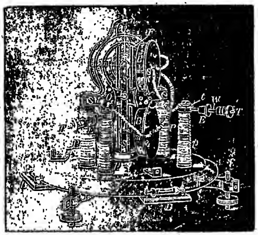


Fig. 84.—THOMSON REFLECTING GALVANOMETER.

any torsion from being put on the fibre. The upper and lower coils are of course wound in opposite directions, so that they both tend to turn the needle in the same direction. The galvanometer here illustrated is Professor's Ayrton's modification of Sir William Thomson's instrument. Its principal feature consists in the fact that the mirror is attached to the vane between the two pairs of coils.

In the Elliott pattern of this instrument, which is the standard type, the mirror is attached to the vane at the centre of the upper pair of coils, and this arrangement necessitates the making of a bell-shaped opening in one of these coils in order that the beam of light, which is thrown on the mirror, may be uninterrupted in its path. In the modification of the instrument here illustrated, the mirror being fixed between the coils, obviates the necessity for any such distortion of the coil, and therefore —by allowing this space to be filled up with wire— makes the instrument more sensitive.

In order that the vane shall hang freely between the coils without touching either, the galvanometer must be quite level, and to insure this, two levels L and L are fixed on the base at right angles to each other. The pillars *p* and *p* are used for supporting the connecting pieces to the coils. The whole is enclosed in a circular glass case through which project the wires W. These wires carry terminals T and T, and also two small ebonite plugs E and E, which are used for maintaining the wires in position by being inserted in circular holes in the glass case; when the galvanometer is in use these plugs are withdrawn, and the insulation of the instrument is thereby raised.

For any kind of delicate testing, this is the one instrument which is in common use.

GERMAN.—XXVIII.

[*Continued from p.* 193.]

Reißen, Einsprechen, ETC.

Reißen = "to tear," "to rend;" also, "to draw," etc.; hence, An sich reißen, "to draw towards *or* to one," "to usurp," "seize upon," as:—Der Sturm riß ganze Bäume aus der Erde, the storm rent whole trees from the earth; Er hat das Vermögen seines Bruders an sich gerissen, he has usurped the fortune of his brother.

Sich um Etwas reißen = "to strive, contend for anything," as:—Die Räuber rissen sich um die Beute, the robbers strove for the booty.

Einsprechen (*lit.*, "to speak in") = "to inculcate by words," "to influence by speaking." Einem Muth, Trost, etc., einsprechen, "to speak courage, consolation, etc., to one" (*i.e.*, "to encourage," "to console," etc.), as:—Der tapfere General besuchte täglich die Schanzen, um den Soldaten Muth und Trost einzusprechen, the valiant general visited the redoubts daily in order to encourage and console the soldiers.

Bei Jemanden einsprechen = "to call on one," "to give one a call," as:—Ich sprach auf einige Augenblicke bei dem Herrn Pfarrer ein, I called for a few moments on the pastor.

EXAMPLES.

Wer ein Vorrecht hat, sucht auch noch an'dere an sich zu reißen.	He who has one privilege seeks (to seize to himself) to usurp others.
Wollen Sie über Havre reisen?	Will you go (travel) viâ Havre?
Ich habe nichts dage'gen, wenn Sie es vor'ziehen.	I have nothing against it, if you prefer it.
Wir ziehen es vor, zu Hause zu bleiben.	We prefer to stay at home.
Der Flei'ßige macht bes'sere Fort'schritte, als der Faule.	The industrious (man) makes better progress than the idle.
Rußland, Östreich, und Preußen rissen sich um das un'glückliche Polen.	Russia, Austria, and Prussia contended about (the) unhappy Poland.

VOCABULARY.

Ab'rufen, to call, call away, recall.
An'fangsgründe, first principles, rudiments, elements.
Behag'lich, pleasing, agreeable, comfortable.
Beson'ders, particularly, especially.
Cigar're, *f.* cigar.
Fortschritt, *m.* progress.
Gelas'senheit, *f.* tranquillity.
Greis, *m.* old man.
Haus'geräth, *n.* household furniture.
Herrschaft, *f.* dominion, mastery, domination.
Kugel, *f.* bullet, ball.
Lan'dungsplatz, *m.* landing-place; place of descent.
Reißen, to tear, seize. (*See above.*)
Un'behaglich, unpleasant, comfortless.
Wiege, *f.* cradle.
Wirthshaus, *n.* inn, public-house.

EXERCISE 178.

Translate into English :—

1. Trotz der Mühe, welche sich der Lehrer gab, wollten die Kinder keine rechten Fortschritte machen. 2. Er machte bedeutende Fortschritte in der deutschen Sprache, nachdem er die ersten Anfangsgründe überwunden hatte. 3. Er entbehrt der nöthigsten Bücher. 4. Eine arme Familie entbehrt oft der nothwendigsten Hausgeräthe. 5. Die Gelassenheit dieses Angeklagten beruhrt auf dem Bewußtsein seiner Unschuld. 6. Der Capitän erzählte uns gestern, daß sich der junge Italiener eine Kugel durch den Kopf geschossen habe. 7. Er schoß dem Bären eine Kugel durch den Kopf. 8. Ich ziehe es vor über Bremen oder Hamburg, anstatt über Havre zu reisen. 9. Ich ziehe das Reiten dem Gehen, und das Fahren dem Reiten vor. 10. Es ist mir in einer warmen Stube behaglicher, als in einer kalten. 11. Es ist ihm am behaglichsten, wenn er nach dem Essen seine Cigarre rauchen kann. 12. Knaben ist es am behaglichsten und auch am gesündesten, wenn sie nach dem Essen eine halbe Stunde spazieren gehen. 13. Ich hatte den ganzen Morgen über ein unbehagliches Gefühl. 14. Die Fürsten Deutschlands haben von Neuem die Herrschaft an sich gerissen. 15. Der Oheim wußte nach und nach das Vermögen seiner Neffen an sich zu reißen. 16. Es ist schon lange her, daß ich ihn gesehen habe. 17. Ist es lange, daß er krank ist? 18. Ja, es sind schon mehr als drei Wochen. 19. Bleibe zu Hause, bis ich zu dir komme, ich werde dich zu einem Spaziergange abholen. 20. Der Tod ruft nicht nur den Greis, sondern auch gar oft den Mann in seinen besten Jahren, den Jüngling und das Kind in der Wiege ab. 21. Da ich wußte, daß mein Freund mit dem Dampfboote ankommen würde, so holte ich ihn von dem Landungsplatze ab. 22. Ich habe diesen Brief heute Morgen von der Post abgeholt. 23. Ich sprach auf meiner Reise in verschiedenen Wirthshäusern ein—aber ich kann keines derselben besonders loben. 24. Ich spreche gewöhnlich bei meine Freunden ein, wenn ich in die Stadt gehe.

EXERCISE 179.

Translate into German :—

1. I made better progress in the German language after I had mastered the first rudiments. 2. The uncle seeks to usurp the fortune of his cousins. 3. Is it long since your brother was taken ill? 4. No, it is not more than a few days since. 5. Will you stop at home till I call on you? 6. It is more pleasant to me to take a walk in the country than to sit at home. 7. When I go to town, I generally call on some of my friends. 8. He prefers studying to all other employments. 9. I prefer walking to riding, and riding to driving. 10. During the battle the general rode along the ranks to encourage his soldiers. 11. It is healthful to children when they can take a walk after school. 12. The robbers strove for the booty which they had taken from the citizens.

Vergleichen, ETC.

Einen Tag um den andern, literally, "one day about the other" (*i.e.*, "every other day"), as :—Er geht einen Tag um den andern in die Stadt, he goes every other day into town; Einen Tag um den andern habe ich Unterricht in der deutschen Sprache, every other day I have instruction in the German language.

Vergleichen = "to compare to *or* with," as :—Hierin ist ihr Niemand zu vergleichen, in this there is no one to be compared to her; Mit Gott, dem Vollkommenen, können wir schwachen, gebrechlichen Menschen uns nicht vergleichen, we, weak and fragile creatures, cannot compare ourselves with God, the All-perfect; Wem ist das Reich Gottes gleich, und wem soll ich es vergleichen? unto what is the kingdom of God like, and whereunto shall I resemble it? (Luke xiii. 18); Vergleichen Sie gefälligst diese Probeblätter mit dem Manuscripte, please to compare these proof-sheets with the manuscript. Sich vergleichen signifies "to accord," "to come to an agreement," as :—Beide Parteien haben sich schon verglichen, both parties have already compounded; Die Gläubiger haben sich mit dem Schuldner verglichen, the creditors have compounded with the debtor.

EXAMPLES.

Der Kaufmann war nicht im Stande, sich auf mehr als fünf und zwanzig Procent' mit seinen Schuldnern zu vergleichen.	The merchant was not able to settle with his debtors at more than twenty-five per cent.
Es wundert mich, daß er dieses Jahr, ohne Schulden zu machen, durch'gekommen ist.	It surprises me that he has come (got) through this year without making (any) debts.
Der Preis einer Waare pflegt nach Um'ständen auf- und ab'zuschlagen.	The price of wares is accustomed to rise and fall according to circumstances.
Einen Tag um den andern hatte ich bei meinem kranken Bruder zu wachen.	Every other day I had to watch with my sick brother.

Man muß sich wundern, daß so etwas noch im neunzehnten Jahrhun'dert gesche'hen kann.	One must be surprised that such a thing can happen in the nineteenth century.
Der Gesand'te hielt eine lange Rede an die Versamm'lung.	The ambassador delivered (held) a long address to the assembly.

VOCABULARY.

Auf'schlagen, to rise.
Beträcht'lich, considerably.
Confect', *n.* comfit, comfiture.
Durch'kommen, to come through, "get through," survive.
Gasthaus, *n.* hotel, inn.
Gebie'ten, to command, bid.
Gläu'biger, *m.* creditor.
Hän'del, *pl.* quarrel.
Held, *m.* champion, hero.
Heldin, *f.* heroine.
Herein'bringen, to bring in.
Leicht'sinnig, light, light-minded.
Nachtisch, *m.* dessert.
Schreien, to cry.
Schuldner, *m.* debtor.
Thurm, *m.* tower.
Verblü'hen, to fade, decay.
Werkzeug, *n.* implement, tool.
Wiederho'len, to repeat, reiterate.

EXERCISE 180.

Translate into English:—

1. Die Gläubiger haben sich mit dem Schuldner auf fünfzig Procent verglichen. 2. Die beiden Kaufleute konnten sich wegen des Preises nicht vergleichen. 3. Ich habe Beides mit einander verglichen. 4. Er hat ihm das Haus auf fünf Jahre vermiethet. 5. Der junge Mann vermiethete sich als Knecht. 6. Man muß sich wundern, daß so etwas noch in unsern Zeiten geschehen kann. 7. Es wundert mich, daß er durchgekommen und nicht gestorben ist. 8. Cicero hielt eine Rede gegen Catilina. 9. Derselbe hielt auch Reden über die Freundschaft, über das Greisenalter und über verschiedene andere Gegenstände. 10. Cäsar hielt eine Rede an seine Soldaten. 11. Der Schüler wiederholte zu Hause noch einmal, was er in der Schule gehört hatte. 12. Wir hörten ein wiederholtes Schreien. 13. Der Preis dieser Waare ist bedeutend aufgeschlagen. 14. Die Früchte sind durch den Krieg beträchtlich aufgeschlagen. 15. Die Klugheit gebietet zuweilen auch dem tapfern Manne, einen Feind, der Händel an ihm sucht, zu meiden. 16. Der politische Flüchtling muß sein Vaterland meiden. 17. Die Gesellschaft eines verdorbenen Menschen soll man meiden. 18. Der Arzt besucht den Kranken einen Tag um den andern. 19. Einen Tag um den andern geht er auf die Jagd. 20. Er handelte noch als Mann so leichtsinnig, wie er als Jüngling gehandelt hatte. 21. Als die ungarische Heldin Jagella und andere ungarische Helden in New-York ankamen, kehrten sie in einem Gasthause ein. 22. Bei der Tafel wurde als Nachtisch ein mit kriegerischen Werkzeugen geschmückter Thurm aus Confect hereingebracht, worauf in deutscher Sprache die Worte standen: „Es leben die ungarischen Helden und Heldinnen!"

EXERCISE 181.

Translate into German:—

1. The creditor has compounded with his debtor at twenty per cent. 2. I could not compound with my creditors respecting the price. 3. Please to compare one with another. 4. I have let my house for five years. 5. A diligent scholar repeats what he has heard at school. 6. In war time the price of provisions rises considerably. 7. It surprises me that he does not avoid the society of such people. 8. We should avoid the society of those who have no good principles. 9. I visit my sister every other day. 10. He acts just as he did in his youth. 11. All the goods have been taken from the merchant, as he could not compound with his creditors. 12. Youth, arm thyself day by day with more wisdom, as the flower of youth decays.

EXAMPLES ILLUSTRATING THE VARIOUS USES OF SOME CONJUNCTIONS AND ADVERBS.

The following sentences illustrate the use of the most important conjunctions and adverbs in German. Though we would not recommend you to learn them by heart or continuously, you will find it of service to you to read them through carefully, and refer to them whenever you come across any of the adverbs or conjunctions given here, and are in doubt as to their meaning:—

Aber, allein, sondern.

Es ist bald gespro'chen, aber schwer gethan'. (Schiller.)	It is soon said, but done with difficulty.
Noch ist er nicht da, aber kommen wird er gewiß'.	He is not yet there, but he will certainly come.
Die Zeichen werden gege'ben, daß das Fest geen'det sei; allein weder Wagen, noch Masken, noch Zu'schauer weichen aus der Stelle. (Göthe.)	The signs are given that the festival is over; but neither the carriages, nor masks, nor spectators leave their places.
Nicht die Sprache an und für sich ist richtig, tüchtig und zierlich, sondern der Geist ist es, der sich darin verkörpert. (Göthe.)	Not the language itself is correct, powerful, and elegant, but the spirit which is embodied throughout.

Als.

Loui'se ist mein Liebling, denn sie hat ein ed'leres Gemüth' und einen fe'steren Charak'ter, als viele junge Damen; nichts als Sanftmuth spricht aus ihren Augen.	Louisa is my favourite, for she has a mind more noble, and a character more firm than many young ladies; nothing but gentleness speaks from her eyes.

Also.

Euch also soll ich trauen, Ihr nicht mir? (Schiller.)	To you then shall I trust; not you to me?
Er hat es selbst gethan', und kann also Niemand tadeln.	He has done it himself, and, consequently, can blame no one.

Auch.

Sie sind davon' heute Nacht, die Jäger auch. (Schiller.)	They are off to-night, and the riflemen also.
So gut er auch ist, so kann ich mich doch nie mit ihm befreun'den.	How good soever he may be, I shall never become intimate with him.

Außerdem.

Alle diese Fürsten wuchsen in keiner höhern Erwar'tung auf als über eine Republik, zu gebie'ten, und keines ihrer Länder konnte ihnen eine an'dere Erfah'rung geben; außerdem' besa'ßen diese Fürsten nichts, als was die Nie'derlande ihnen gaben. (Schiller.)	All these princes grew up with no higher expectation than that of governing a republic, and none of their states could afford them any other experience; besides, these princes possessed nothing but what the Netherlonds gave them.

Da.

Da du hier bist, will ich mit dir aus'gehen.	Since you are here, I will go out with you.
Da der Wind aus Westen kommt, wird es regnen.	As the wind comes from the west, it will rain.

Daher, damit, dann.

Die größte Wahr'scheinlichkeit der Erfül'lung läßt noch einen Zweifel zu; daher' ist das Gehoff'te, wenn es in der Wirk'lichkeit eintritt, je'derzeit überrasch'end. (Göthe.)	The greatest probability of (the) accomplishment (still) admits of (a) doubt; therefore it is that hope, when it becomes a reality, always surprises.
Heizen Sie schnell die Stube, damit' wir die nassen Kleider aus- und trock'ene an'ziehen können.	Warm the room immediately, that we may take off our (the) wet clothes, and put on dry (ones).
Erst bete, dann ar'beite.	First pray, then work.

Darum, deßwegen, deßhalb.

Nichts nennt er sein, als seinen Rit'termantel; darum sieht er jedes Bie'dermanns Glück mit scheelen Augen an. (Schiller.)	He calls nothing his, but his knight's cloak; he, therefore (*or* on that account), looks upon every honest man's fortune with envy.
Das Wahre ist eine Fackel, aber eine ungeheu're; deß'wegen suchen wir Alle nur blinzend so daran' vor-bei'zukommen. (Göthe.)	(The) truth is a torch, but an immense one; therefore we all attempt, only blinking at it, to pass by.
Der Haß ist ein acti'ves Miß'vergnügen, der Neid ein passi'ves; deßhalb darf man sich nicht wundern, wenn der Neid so schnell in Haß ü'bergeht. (Göthe.)	(The) hatred is an active displeasure, (the) envy a passive one; therefore one must not be surprised if (the) envy readily passes over into hatred.

GERMAN TRANSLATION.

Johann Ludwig Uhland was born at Tübingen, in Würtemberg, in 1787. He studied low, and took his degree of Doctor of Laws (1810). He afterwards went to Paris to pursue the study of law, but spent much time in deciphering monuscripts in the Imperial Library. At this time he wroto some of his best ballads. He was much interested in the constitutional freedom of his native country. In 1819 he was elected a member of the Würtemburgian Parliament. He was a keen supporter of the Charter which King William tried to suppress. To his political poems he owes much of his popularity. He wrote a series of essays on "Old French Epio Pootry" and on "Walther von der Vogelweide," for which he can claim a high place among German scholars. His plays, *Herzog Ernst von Schwaben* and *Ludwig der Baier*, lack spirit.

Der gute Kamerad.

Ich hatt' einen Kameraden,
Einen bessern find'st du nit.
Die Trommel schlug zum Streite,
Er ging an meiner Seite
In gleichem Schritt und Tritt.

Eine Kugel kam geflogen,
Gilt's mir oder gilt es dir?
Ihm hat es weggerissen,
Er liegt mir vor den Füssen,
Als wär's ein Stück von mir.

Will mir die Hand noch reichen,
Derweil ich eben lad'.
Kann dir die Hand nicht geben;
Bleib du im ew'gen Leben,
Mein guter Kamerad!

Johann Ludwig Uhland.

KEY TO TRANSLATIONS FROM GERMAN (p. 192).

THE DANCING BEAR.

A dancing bear had torn away from his chain; (he) came back again into the forest, and danced to his troop a master-piece on his hind feet, as usual. "See," cried he, "that is Art; that is what you learn in the world. Do it after me, if

it pleases you, and if you can!" "Humph," growled an old bear, "art like that, it is so difficult; it is so curious; it displays your vulgar mind and your bondage."

To be a great courtier, a man to whom flattery and cunning take the place of sense and virtue; who rises through plots, steals the Prince's favour, plays with his word and oath as with compliments—to be such a man, to be a great courtier, does that imply praise or blame?

KEY TO EXERCISES.

Ex. 172.—1. When Rudolph of Habsburg had become Emperor of Germany, the internal dissensions and the so-called club-law ceased in this empire. 2. After they had killed a few stags, they desisted from hunting. 3. It ceases raining, and we now can continue our journey. 4. My brother is at home; he has already been a week in bed. 5. In Germany there are other manners and customs than in America. 6. The imperial diets were held in Ratisbon in later years. 7. The high school at Breslau is among the best in Germany. 8. They were just dining as we arrived there. 9. They were not accustomed to take their supper until they had done all their day's work. 10. They took their dinner in summer during fine weather under a linden-tree, which stood in the yard. 11. When the cholera raged in Paris, thousands upon thousands died of it. 12. The soldiers take the field. 13. In the last storm several ships sank. 14. The beggar goes from door to door, and from village to village. 15. This redounds to my honour, to his disgrace. 16. You might do it for my gratification. 17. The enemy steers with all sails towards the east. 18. That is too good for him. 19. I am only too certain that it will happen so. 20. That may be done too when we have first regulated our own affairs. 21. Friend, life is an earnest business; suffer its hardships: thus only will the voyage be easy to you. 22. Finally, thou landest, after all, safely on shore in thy harbour; it is called the grave. 23. He has ruined his own and his friends' fortune. 24. He has ruined his health by these labours. 25. Nelson destroyed the French fleet. 26. If he is not careful, his whole business may be ruined in a short time.

Ex. 173.—1. Hören Sie auf das, was ich Ihnen sage? 2. Ja, ich höre auf das, was Sie sagen. 3. Glauben Sie, daß er willig auf jenen Vorschlag hören wird? 4. Wenn Sie auf das achten, was der Lehrer Ihnen vorträgt, so erlangen Sie Kenntnisse. 5. Können wir bei Ihnen bleiben, bis der Sturm nachgelassen hat? 6. Sobald der Regen aufhört, werden wir unsere Reise fortsetzen. 7. Sobald wir unsern Lehrer erblickten, hörten wir auf zu spielen, und fingen an zu schreiben. 8. Hunderte und aber Hunderte verloren ihr Leben bei der Revolution in Frankreich. 9. Nachdem seine unbedachtsame Speculation ihn zu Grunde gerichtet hatte, wurde er vorsichtiger. 10. Es gereicht einem Könige zur Ehre, wenn er sein Land in Frieden regiert. 11. Verzage nicht, wenn dir das Glück nicht lächelt, oder selbst wenn du in das tiefste Elend versunken bist; denn es kann Rath werden, ehe du es glaubst daß du aller deiner Leiden durch die Vorsehung enthoben wirst.

Ex. 174.—1. In human life there are sometimes cloudy moments. 2. Now and then one must give the mind relaxation. 3. He has frequently been here. 4. I have frequently said this. 5. Sometimes, too, it goes wrong. 6. There is not time now to take a walk. 7. He has still sufficient time to finish this work to-day. 8. He will have more time another day to visit you. 9. This house is worth a thousand dollars. 10. My coat is worth ten dollars. 11. That man is worth five hundred dollars. 12. He is worth ten thousand dollars. 13. This family has a good competency. 14. That poor day-labourer has only a scanty subsistence. 15. There came so many political fugitives that all of them could not find shelter. 16. All the soldiers found shelter in the barns and stables of the peasants. 17. Yesterday I paid the merchant his bill. 18. He has not yet paid the tailor for the coat. 19. He forgot to pay the shoemaker for the boots. 20. The sick person asks for a glass of water. 21. I long to know the truth of this matter. 22. I wish to spend a cheerful hour in the circle of my dear family. 23. I wish for the book that lies there. 24. One thing I beg of you, be careful in the choice of your friends. 25. The man asked for patience and forbearance. 26. As he begged his pardon, he could not be angry any longer. 27. I ask you for a glass of wine.

Ex. 175.—1. Mein Haus ist tausend Franken werth, aber das meines Bruders fünfzehnhundert. 2. Jenes Banquiers Vermögen ist tausend Pfund größer als jene Summe. 3. Zufriedenheit ist von größerem Werthe als aller Reichthum der Erde. 4. Wir konnten bei unserer Ankunft in Amerika nirgends ein Unterkommen finden, denn alle Gasthäuser waren voll. 5. Jeder, der nach Australien geht, kann ein Unterkommen finden. 6. Diejenigen, welche ein nothdürftiges Auskommen haben, sind zuweilen die Werkzeuge der größten Verbrechen. 7. Mein Bruder bittet mich, geduldig und nachsichtig zu sein. 8. Er sucht meine Vergebung, und deßhalb kann ich ihm nicht länger zürnen. 9. Die Nothwendigkeit erfordert, daß wir unserm Körper zuweilen Erholung gönnen. 10. Da er seinen Rock zu bezahlen vergaß, so ersuchte ihn der Schneider, denselben zu bezahlen.

Ex. 176.—1. At the outbreak of the revolution in Berlin there was fighting till late at night. 2. He gave him the book, with the request to keep it clean. 3. A letter was sent to him yesterday. 4. I showed him the new paintings which I had bought at the auction. 5. Music is his most favourite pastime. 6. He sings, jokes, and laughs for pastime, instead of occupying himself with serious matters. 7. I often take a walk in the morning, at noon, and in the evening. 8. They pursued the enemy as far as the frontiers of the country. 9. She had perused the book up to this passage. 10. They ventured out as far as this place, but not farther. 11. He tried in vain to solve the question. 12. They took pains to gain the good-will of their master. 13. He strives to get wealth. 14. I have been here (in this town) about five years. 15. I have been here this half-hour (in this room). 16. Has anybody been here during my absence? 17. Mr. N. has been here and wished to speak to you. 18. A Berlin paper gives us the following interesting communication. 19. The Nuremberg ginger-bread is celebrated through all Germany. 20. The Heidelberg cask is known on account of its size. 21. Good-bye, sir. 22. Remember me to your family. 23. He took leave of the company. 24. As the old huntsman could not otherwise give vent to his fury, he beat his dogs.

Ex. 177.—1. Mein Freund schickte mir ein Buch mit der Bitte, es durchzulesen. 2. Ich habe Ihr Buch bis zum zweiten Kapitel durchgelesen. 3. Ein Packet wurde mir gestern zugeschickt. 4. Studiren ist mein liebster Zeitvertreib. 5. Des Morgens studiere ich, und des Abends unterrichte ich meine Schüler. 6. Unseres Freundes wegen brauchen wir uns

nicht zu bemühen; er bedarf unserer Hülfe nicht. 7. Während der Abwesenheit unseres Lehrers spielten wir, anstatt zu lernen. 8. Wie lange sind Sie in London gewesen? 9. Ich bin beinahe drei Jahre hier. 10. War mein Bruder während meiner Abwesenheit hier? 11. Nein, er war nicht hier. 12. Darf ich Sie bemühen, mir diesen Brief zu schreiben? 13. Ein fleißiger Knabe bemüht sich, Kenntnisse zu erlangen.

CHEMISTRY.—XIV.

[*Continued from p. 197.*]

ARSENIC — ANTIMONY — BISMUTH — MERCURY — CALOMEL—CORROSIVE SUBLIMATE—SILVER.

Arsenic (As), atomic weight 75, specific gravity 5·7.—This element stands on the borderland between the metals and the non-metals; in many of its compounds it closely resembles phosphorus on the one hand, and antimony on the other. In fact, it is a member of the group Nitrogen, Phosphorus, Arsenic, Antimony, and Bismuth. Thus all these elements are pentads, and they all, except Bismuth, combine with three atoms of hydrogen to form gaseous compounds, NH_3, PH_3, etc.; they form various oxides, a complete series of which is known in the case of Nitrogen. The group also includes some rare metals, Vanadium, Niobium, Didymium, Tantalum, and Erbium.

Arsenic is rarely found free, it more usually occurs in various compounds with iron, sulphur, etc., especially as arsenical iron pyrites, or Mispickel, ($Fe_2S_2As_2$); it is also found as Realgar (As_2S_2), and Orpiment (As_2S_3), in showy orange-red and yellow crystals respectively. (See Coloured Plate, "Ores of Metals.")

Arsenic is usually obtained by heating arsenical iron pyrites, $Fe_2S_2As_2 = 2FeS + 2As$. The arsenic is evolved as a vapour, which condenses into a compact, brittle, crystalline, greyish-black metallic-looking mass. When heated it does not melt, but passes, at about 180° Cent., into vapour, giving off a characteristic odour which is usually said to resemble that of garlic. Arsenic oxidises rapidly in moist air; when heated in air to 180° it burns with a livid blue flame, when burnt in oxygen it emits a brilliant white light. It is oxidised by strong nitric and strong sulphuric acids. Hydrochloric acid has no action upon it. Arsenic is chiefly used for hardening ordinary lead shot, which contain about 5 per cent. of arsenic.

Hydrogen Arsenide, Arseniuretted Hydrogen, Arsine (AsH_3).—This colourless gas is exceedingly poisonous; it is formed whenever nascent hydrogen comes into contact with an arsenic compound; thus, if a small quantity of a solution of oxide of arsenic be poured into a hydrogen-generating apparatus (*see* Fig. 5), the hydrogen which is evolved is soon contaminated with hydrogen arsenide, acquiring a garlic odour and burning with a livid blue flame. This easy method of producing AsH_3 furnishes us with an exceedingly delicate test for the presence of arsenic; it is known as Marsh's test. If the gas be passed

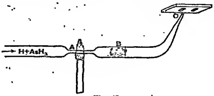


Fig. 46.

through a tube of difficultly fusible glass, drawn out as shown in Fig. 46, and the narrow portion of the tube at A be made red-hot by a Bunsen flame, the AsH_3 is decomposed into hydrogen and arsenic, the latter forming a smooth black shining deposit, usually called a "mirror," in the cold part of the tube at B. If the gas be lighted at the end, C, it burns with a livid blue flame; if a white china plate be held in the flame, the arsenic is deposited as a shining black stain on the porcelain. The corresponding compound of antimony, SbH_3, also burns with a bluish flame, which gives black stains on porcelain, but the arsenic stains are soluble in a solution of sodium hypochlorite, NaClO, while the antimony stains are insoluble in that fluid. Arsenic, like phosphorus, forms two oxides, arsenious (As_4O_6), and arsenic (As_2O_5).

Arsenious Oxide (white arsenic) (As_4O_6).—This is the substance popularly called arsenic. It is obtained in large quantities during the roasting of ores of copper, etc., which contain arsenic. The arsenic oxidises and sublimes as As_4O_6. It is usually seen as a white powder, which has hardly any taste and no smell. It is largely used in the manufacture of arsenical pigments, glass, etc. When heated in a tube it volatilises and condenses in brilliant glistening octahedral crystals. If sublimed at a very high temperature, another modification is produced, which is termed vitreous or amorphous; this is at first transparent, but gradually becomes opaque, and then forms a hard cake resembling white opal glass. Ordinary arsenious oxide is very slightly soluble in water; it dissolves in hydrochloric acid, and when boiled with a solution of potassium or sodium hydrate or carbonate, forming arsenites of these metals. Copper sulphate when added to a solution of an arsenite gives a brilliant green precipitate of Scheele's green, $CuHAsO_3$. Silver nitrate gives a yellow precipitate

of silver arsenite. Hydrogen sulphide in the presence of dilute hydrochloric acid gives a yellow precipitate of As_2S_3. In cases of poisoning by arsenic, the best plan is first to administer an emetic of about fifteen grains of zinc sulphate dissolved in warm water, and then large quantities of freshly precipitated ferric hydrate, which can be most readily prepared by adding carbonate of soda to a solution of perchloride of iron. In the absence of either of the above, large quantities of oil should be given.

Arsenic Oxide (As_2O_5).—When arsenic is burned in oxygen it does not form As_2O_5, but As_4O_6. The higher oxide, As_2O_5, can be obtained as follows:—As_4O_6 is boiled with strong nitric acid, or aqua regia, or acted upon by chlorine, $As_4O_6+6H_2O+O_4=4A_2AsO_4$: a solution of arsenic acid is thus obtained; it occurs in commerce as a thick acid liquid depositing crystals of $2H_3AsO_4+H_2O$. If these crystals be heated *to a low red heat*, As_2O_5, the anhydrous oxide, is formed. Arsenic oxide is a white amorphous substance which dissolves slowly, but to a great extent, in water; it has an acid metallic taste and is poisonous, but in a less degree than arsenious oxide. It forms salts, the arsenates, which in many respects resemble the phosphates; they differ in giving a reddish-brown precipitate with silver nitrate, the phosphates giving a yellow precipitate. There are three sulphides of arsenic, Realgar (As_2S_2), Orpiment (As_2S_3), and Arsenic pentasulphide (As_2S_5).

Realgar (As_2S_2).—This is found native in orange-red crystals; the substance which occurs in trade under this name is usually a mixture of As_2S_3 with As_2O_3.

Orpiment (As_2S_3) occurs native in yellow crystals; it can be obtained as a yellow precipitate by passing hydrogen sulphide through a solution of an arsenious compound acidified with dilute hydrochloric acid, or by subliming a mixture of arsenious oxide and sulphur; it is used as a pigment under the name of King's Yellow.

Arsenic compounds when heated in a bulb tube (Fig. 47) with some powdered charcoal yield a black shining mirror of arsenic. When boiled with dilute hydrochloric acid and a piece of bright copper, a grey film of arsenic is deposited on the copper; if this copper be dried, and then heated gently in a small tube, the arsenic oxidises and sublimes in glistening crystals of As_4O_6. This is known as Reinsch's test. H_2S in the presence of dilute HCl gives a yellow precipitate of As_2S_3; with arsenates this precipitate only forms after some time.

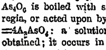


Fig. 47.

Antimony, Sb (*stibium*, its Latin name), atomic weight 122, specific gravity 6·7, melts at 432° Cent.—This metal occurs principally as the sulphide Stibnite, Sb_2S_3; it is also found combined with lead, silver, etc. It is prepared by heating the ore in vertical retorts, which are perforated at the bottom; the sulphide melts and runs out, it is then either fused with metallic iron, $Sb_2S_3+3Fe=3FeS+2Sb$, or it is roasted and converted into oxide, which is then heated with carbon, $Sb_2O_3+3C=3CO+2Sb$. Antimony is a white metal, hard and very brittle, so that it can be powdered in an ordinary mortar; it does not oxidise at ordinary temperatures, but when heated burns forming an oxide; it is soluble in hot hydrochloric acid, and in a mixture of two parts of hydrochloric acid to one of nitric acid (aqua regia). It forms when melted with tin and lead the alloy used for casting "type" for printing—type-metal—which contains 12 lead, 5 antimony, 3 tin. "Britannia" metal contains 85 tin, 15 antimony, and 2 zinc.

Hydrogen Antimonide, Antimonetted Hydrogen, Stibine (SbH_3).—This is formed by the action of nascent hydrogen on an antimony compound. If a solution of an antimony compound be added to a hydrogen apparatus (*see* Fig. 5), the hydrogen which is evolved will be found to contain SbH_3; it burns with a bluish-grey flame. (*See* Arsenic, p. 257.) Antimony forms three oxides, Sb_2O_3, Sb_2O_4, Sb_2O_5.

Antimony Trichloride ($SbCl_3$) is obtained by distilling a mixture of corrosive sublimate and antimony sulphide; it forms a crystalline mass, which absorbs water from the air; a strong solution of this substance is known as "liquid butter of antimony," and is used for browning steel and iron gun-barrels. If much water is added to a solution of this substance, a white precipitate is thrown down, which is an oxychloride, SbOCl; it is soluble in tartaric acid.

Antimony Sulphide, Stibnite (Sb_2S_3), occurs native, sometimes most beautifully crystallised in steel-grey crystals; when hydrogen sulphide is passed into a solution containing antimony, an orange precipitate, Sb_2S_3, is formed, which turns black when dried and heated. This substance is used for fireworks, lucifer match heads, for vulcanising india-rubber, etc.

Tartar Emetic ($KSbOC_4H_4O_6$) is obtained by boiling antimonious oxide, Sb_2O_3, with tartaric acid: it is used in medicine as an emetic; in large doses it is poisonous.

Solutions of antimony compounds give with H_2S in the presence of dilute HCl, an orange precipitate, which is soluble in potassium hydrate.

When solid antimony compounds are fused on

charcoal with sodium carbonate, a brittle white globule is obtained, which continues to smoke for a moment or two after the blow-pipe flame has been withdrawn.

Bismuth (Bi), atomic weight 210, melts at 270° Cent., specific gravity 9·9, is found chiefly native. The ore is simply heated, when the melted bismuth runs out; it occurs chiefly in Saxony. It is a hard brittle metal, in colour, whitish, but with a distinct reddish tinge; it can be easily obtained in crystals. Hydrochloric and sulphuric acids have no action upon it, but nitric acid and aqua regia dissolve it readily in the cold. Its compounds are used in medicine, and the metal is a constituent of the various fusible metals. Thus Newton's fusible metal melts at 94·5° Cent., Bi 8 parts, Pb 5 parts, Sn 3 parts. Rose's metal melts at 94° Cent., Bi 2, Pb 1, Sn 1. Wood's metal melts at 61° Cent., Bi 4, Pb 2, Sn 1, Cd 1.

Bismuth forms four oxides, Bi_2O_2, Bi_2O_3, Bi_2O_4, and Bi_2O_5. The most important compounds are the oxide Bi_2O_3 and its salts.

Bi_2O_3 is obtained as a yellow-white powder by igniting the nitrate or carbonate.

Bismuth Chloride ($BiCl_3$) is obtained in solution by dissolving the oxide Bi_2O_3 in hydrochloric acid; when diluted with much water it gives, like antimony trichloride, a white precipitate, BiOCl, which is however insoluble in tartaric acid.

Bismuth Nitrate, $Bi(NO_3)_3 + 3H_2O$, is a white crystalline salt, obtained by dissolving the metal in nitric acid, and evaporating; it is used in medicine. Solutions of bismuth give, with hydrochloric acid and H_2S, a brownish-black precipitate. Solutions in HCl, when diluted with a *large quantity* of water, give a white precipitate, insoluble in tartaric acid.

Solid compounds of bismuth, when heated on charcoal with sodium carbonate, give a brittle white globule, surrounded by an incrustation, which is orange when hot, yellow when cold.

We now come to a group of metals whose oxides when heated evolve oxygen and are reduced to the metallic state; they are sometimes termed the "noble metals," Mercury, Silver, Gold, Platinum, Palladium, Iridium, Rhodium, Osmium, and Ruthenium.

Mercury, Hg (*hydrargyrum*, Latin, liquid silver), atomic weight 200, boils at 357° Cent., specific gravity 13·6. This is the only liquid metallic element, it sometimes occurs native, but the great ore is Cinnabar, HgS, which occurs in Spain, California, etc. It is easily reduced to the metallic state, either by simply heating in a current of air or by heating with limestone, $CaCO_3$, in either case the mercury boils over and the vapour is condensed in a series of brick chambers, or in a series of clay tubes termed "aludels." It is usually purified by distillation.

Mercury combines with most metals to form amalgams, from which the mercury can be driven off by heat; the two principal exceptions are platinum and iron. Mercury is a silvery-white metal, which is not oxidised at ordinary temperatures, but when heated to its boiling-point, the red oxide, HgO, is formed. Hydrochloric acid does not act upon mercury, sulphuric acid only attacks it when hot and strong, but dilute nitric acid dissolves it readily.

Mercury forms two oxides, mercurous (Hg_2O), and mercuric (HgO). Mercurous oxide is obtained as a blackish powder by acting on calomel (Hg_2Cl_2), with potassium or ammonium hydrate.

Mercuric Oxide (red precipitate) is prepared by heating mercury to its boiling-point, or mercuric nitrate, $Hg(NO_3)_2$, until no red fumes are evolved.

There are two chlorides corresponding to the above oxides, calomel, Hg_2Cl_2, which is a valuable drug, and the poisonous corrosive sublimate, $HgCl_2$.

Mercurous Chloride (calomel), Hg_2Cl_2, is prepared by subliming corrosive sublimate with mercury. The product must be most carefully washed. Calomel is a whitish powder, which is quite insoluble in water, and in ordinary acids; it is soluble in aqua regia. When heated, it splits up into corrosive sublimate and mercury—

$$Hg_2Cl_2 = HgCl_2 + Hg.$$

Mercuric Chloride (corrosive sublimate), $HgCl_2$, is obtained by subliming dry common salt and mercuric sulphate, with a little black oxide of manganese; it is a white crystalline substance soluble in water and very poisonous (antidote, white of egg), its solution coagulates or precipitates white of egg, and other albuminous bodies; it is much used for preserving skins of small birds, animals, etc. If ammonium hydrate be added to a solution of corrosive sublimate, a "white precipitate" is produced.

Mercuric Iodide (HgI_2) is obtained as a scarlet precipitate by adding cautiously a solution of potassium iodide to mercuric chloride; the precipitate dissolves completely in an excess of the potassium iodide. If this solution (of HgI_2 in KI) be made strongly alkaline with potassium hydrate, it forms *Nessler's solution*, which is an exceedingly delicate test for ammonia, $\frac{1}{100000}$th of a gram (1 gram = 15·5 grains) giving a distinct yellowish-brown colour when a small quantity of the Nessler test is added. If the scarlet iodide be heated to 150° Cent., it turns yellow, but the yellow modification again becomes scarlet when scratched.

Mercuric Nitrate, $Hg(NO_3)_2$, is prepared by heating mercury with an excess of strong nitric acid.

and evaporating the solution; it forms colourless crystals. Its solution gives a white precipitate with urea.

Mercuric Sulphide (cinnabar, vermilion), HgS. —When precipitated by passing hydrogen sulphide through a solution of corrosive sublimate, mercuric sulphide is black, when crystalline it is red. Mercuric sulphide is insoluble in nitric acid.

Mercurous salts give a white precipitate when dilute HCl is added. This precipitate turns black on the addition of an excess of ammonia. Mercuric salts give no precipitate with HCl, but give a black precipitate with H_2S, insoluble in strong nitric acid. When potassium iodide solution is added in small quantities to a mercuric salt, a scarlet precipitate is formed; this dissolves up to a colourless fluid in excess of KI. If a solid mercury compound be gently heated in a small bulb-tube with *dry* sodium carbonate, a sublimate of globules of quicksilver is obtained.

Silver, Ag (*argentum*, Latin), atomic weight 108, specific gravity 10·6, melts at 1000° Cent.—This beautiful white metal is sometimes found native, but its more common ores are the sulphide Ag_2S, "silver glance," the chloride or "horn silver," AgCl; considerable quantities of silver are also found in galena (*see* p. 194). Silver is found in Mexico, California, Australia, South America, etc. There are several methods of extracting silver from its ores. (i.) The silver ore is fused with metallic lead, the lead dissolves out the silver, and a rich alloy is obtained; this alloy is then subjected to "cupellation," which consists in heating the alloy to a high temperature in a strong current of air; the lead is rapidly oxidised into litharge, PbO, which melts readily, and partly runs away and is partly absorbed by the bed of the furnace, which is made of bone ash, $Ca_3(PO_4)_2$.

(ii.) Another process used in Mexico is known as the "amalgamation process"; it has arisen owing to the dearness of fuel and abundance of mercury in the district. The ore, which consists of chloride and sulphide with some metallic silver, is ground up by mules with water, salt, roasted copper pyrites, and mercury for 15 to 45 days: the reactions are complex, but the result is that the silver is first converted into chloride, and this is reduced to the metallic state by the mercury, and we have calomel, which is washed away, and metallic silver, which remains amalgamated with the excess of mercury. The mercury is finally distilled off by heat, and a spongy mass of metallic silver left.

The methods of Pattinson and Parkes for extracting small quantities of silver from lead have already been noticed under Lead (*see* p. 195).

A very instructive experiment is to prepare some pure silver from a threepenny piece. The coin is dissolved in dilute nitric acid with the aid of a gentle heat; when a blue solution is obtained containing silver and copper nitrates; dilute hydrochloric acid is then added to the hot solution, when the silver is thrown down as a white precipitate, AgCl; after vigorous agitation with a glass rod, this settles rapidly and completely to the bottom of the beaker, the blue solution containing the copper nitrate and chloride is carefully poured off, and the beaker filled up with hot water. The silver chloride is stirred, allowed to settle, and the water poured away; this washing is repeated until the wash-water gives no perceptible blue colour with an excess of ammonium hydrate. This indicates that all the copper has been washed out. The pure silver chloride can then be reduced to the metallic state by fusing it with sodium carbonate on charcoal—

$$2AgCl + Na_2CO_3 = 2NaCl + 2Ag + CO_2 + O.$$

Silver is the whitest of the metals, it is very ductile and malleable, it is the best conductor of heat and electricity; when melted in air it absorbs 22 times its volume of oxygen, this gas is given off at the moment that it solidifies, so suddenly that sometimes much silver is lost by this "spitting." Silver tarnishes rapidly in the presence of sulphur compounds; it is insoluble in hydrochloric acid, but dissolves in hot strong sulphuric acid, and very readily in dilute nitric acid; it is not acted upon by fused caustic alkalies (KHO, NaHO, etc.). Silver is too soft when pure for ordinary use; for spoons, jewellery, coins, etc., it is always alloyed with copper. There is only one standard silver in this country, which is now stamped with a lion "passant," and, if it has paid duty, with the head of the reigning sovereign; it contains 925 parts of silver and 75 parts of copper.

A simple test to distinguish silver articles is to file a portion of the surface bright, and then place on it a drop of silver nitrate solution; if it is silver no change will take place, but if it is German silver, pewter, brass, etc., the spot will turn black.

Silver forms three oxides, only one of which (Ag_2O) forms salts.

Argentic Oxide (Ag_2O) is obtained as a black or brown powder by adding potassium hydrate to a solution of silver nitrate; when acted on by ammonia this forms "fulminating silver," an explosive substance, NH_2Ag, which must not be confounded with fulminate of silver, $AgC_2N_2O_2$.

Silver Nitrate ($AgNO_3$).—This is the most important soluble salt of silver; it is obtained by dissolving silver in nitric acid and evaporating the solution. It occurs in large colourless crystalline

plates. When fused into sticks it forms the lunar caustic of the surgeon. It stains the skin and other organic substances black. Large quantities are used for photography; it is also employed in the manufacture of marking-ink.

Silver Chloride (AgCl) is obtained as a white precipitate by adding hydrochloric acid to a solution of any silver salt; it is easily soluble in ammonium hydrate, potassium cyanide, and sodium thiosulphate (so-called hyposulphite of soda); when heated it fuses into a dark brown horn-like mass, which can be cut by a knife, and so is termed "horn silver."

Silver Bromide (AgBr) is prepared by adding potassium bromide to a solution of a silver salt, as a whitish precipitate soluble with some difficulty in ammonia.

Silver Iodide (AgI) is prepared in a similar way by using potassium iodide instead of bromide; it is yellowish, and is insoluble in ammonium hydrate. Both the chloride, bromide, and iodide of silver when exposed to light are decomposed, and eventually turn black owing to the separation of silver. This sensitiveness to light forms the basis of most photographic processes.

Solutions of silver salts give with HCl the characteristic white curdy precipitate of AgCl, easily soluble in ammonia. Hydrogen sulphide gives a black precipitate of Ag_2S.

When a solid silver compound is fused on charcoal with sodium carbonate, a white malleable globule of silver is obtained.

LATIN.—XXIX.

[*Continued from p. 200.*]

LATIN READINGS.

We have now put you in possession of the main facts of the Latin language, and you should be able, by reading the best authors, rapidly to advance your acquaintance with the language.

VERGIL.—III.

Æneas is welcomed to Dido's court, and he and his followers are entertained by the Queen. At last Æneas is induced to tell the story of Troy's fall. He begins by relating how the Greeks, after vainly besieging Troy for ten years, build a wooden horse, which they fill with armed men, and, pretending that it is an offering to Pallas, seek to have it admitted within the walls of Troy:—

Conticuere omnes, intentique ora tenebant.
Inde toro pater Aeneas sic orsus ab alto:—
"Infandum, Regina, jubes renovare dolorem;
Trojanas ut opes et lamentabile regnum
Eruerint Danai, quaeque ipse miserrima vidi
Et quorum pars magna fui. Quis talia fando
Myrmidonum, Dolopumve, aut duri miles Ulixi,
Temperet a lacrimis? et jam nox humida caelo
Praecipitat, suadentque cadentia sidera somnos.
Sed si tantus amor casus cognoscere nostros.
Et breviter Trojae supremum audire laborem;
Quamquam animus meminisse horret, luctuque refugit,
Incipiam. Fracti bello, fatisque repulsi,
Doctores Danaum, tot jam labentibus annis,
Instar montis equum, divina Palladis arte,
Aedificant, sectaque intexunt abiete costas.
Votum pro reditu simulant; ea fama vagatur.
Huc, delecta virum sortiti corpora furtim
Includunt caeco lateri, penitusque cavernas
Ingentes uterumque armato milite complent."

Meanwhile the Grecian fleet has sailed away to Tenedos, an island off the coast of Asia, and there the ships are concealed. The Trojans think that the Greeks have departed altogether, and a fierce discussion arises as to whether the wooden horse shall be admitted or not. Lāŏcŏŏn opposes the admission:—

"Scinditur incertum studia in contraria vulgus.
Primus ibi ante omnes, magna comitante caterva,
Laocoon ardens summa decurrit ab arce;
Et procul: 'O miseri, quae tanta insania, cives?
Creditis avectos hostes? aut ulla putatis
Dona carere dolis Danaum? sic notus Ulixes?
Aut hoc inclusi ligno occultantur Achivi,
Aut haec in nostros fabricata est machina muros,
Inspectura domos, venturaque desuper urbi;
Aut aliquis latet error: equo ne credite, Teucri.
Quidquid id est, timeo Danaos et dona ferentes.'
Sic fatus, validis ingentem viribus hastam
In latus, inque feri curvam compagibus alvum
Contorsit. Stetit illa tremens, uteroque recusso
Insonuere cavae gemitumque dedere cavernae.
Et, si fata deum, si mens non laeva fuisset,
Impulerat ferro Argolicas foedare latebras:
Trojaque nunc stares, Priamique arx alta maneres."

The matter is hotly contested; and while Laocoon is offering sacrifice as the priest of Neptune, two snakes are seen coming over the sea. The following passage, describing how they fasten on Laocoon and his two sons, will serve to illustrate the celebrated statue of Laocoon (a work of the Rhodian school), which Vergil had doubtless seen:—

"Diffugimus visu exsangues: illi agmine certo
Laocoonta petunt. Et primum parva duorum
Corpora natorum serpens amplexus uterque
Implicat, et miseros morsu depascitur artus;
Post ipsum, auxilio subeuntem ac tela ferentem,

Corripiunt, spirisque ligant ingentibus; et jam
Bis medium amplexi, bis collo squamea circum
Terga dati, superant capite et cervicibus altis.
Ille simul manibus tendit divellere nodos,
Perfusus sanie vittas atroque veneno;
Clamores simul horrendos ad sidera tollit."

The destruction of Laocoon is regarded as a judgment on his impiety. The horse is admitted; and at night the armed Greeks steal out, throw open the gates to their comrades, who return from Tenedos, and thus they accomplish the sack of Troy.

NOTES.

1. *Intenti.* The adjective is used like an adverb.

Ora tenebant = "held their countenances in attention."

2. *Orsus,* from *ordior.*

3. *Infandum* ("unspeakable") naturally implies the idea of "horrible," "too cruel to be told." Its position at the beginning of the line makes the word very emphatic.

4. *Ut* ("how") must be taken with *eruerint;* the phrase explains *renovare dolorem.*

Lamentabile is part of the predicate.

5. *Danai.* A name used for the Greeks.

Quaeque (not from *quisque*) = *et quae.*

6. *Pars magna fui.* "I was a large part"—*i.e.,* "I had a large share."

7. *Myrmidonum Dolopumve.* The people who followed Achilles, the greatest hero of the Greeks. Even the sternest Greeks, he means, would feel some pity in telling the tale of Troy.

8. *Caelo,* the ablative after *praecipitat* in prose would require a preposition.

10. *Tantus amor,* sc. *est.* The auxiliary is frequently omitted. *Cognoscere* is dependent on *amor est.*

11. *Laborem,* "labour;" therefore, "toil," "distress," "suffering."

13. *Fracti,* "broken"—*i.e.,* "worn out."

14. *Labentibus* Notice the force of the present participle, "Now that so many years were gliding away."

15. *Instar,* which is a neuter substantive meaning "likeness," is used as an adverb = "like," "after the fashion of." *Instar montis* refers to the huge size of the horse.

Palladis. Pallas (or Minerva) was the goddess who championed the cause of the Greeks against the Trojans.

16. *Secta abiete,* "with cut fir"—*i.e.,* "with planks of fir."

17. *Huc,* "into this." *Delecta virum corpora,* "picked heroes." *Sortiti* should properly mean "having chosen by lot," but *delecta* conflicts with this interpretation, and *sortiti,* therefore, must be taken in the sense of "having chosen."

18. *Caeco lateri.* Dative after *includunt,* explains *huc.*

19. *Cavernas uterumque.* These two substantives form one idea, "the caverns of the belly." This idiom is called *hendiadys* (= one idea expressed by means of two).

20. *Milite.* The singular of *miles* and of some other words is often used collectively to denote a multitude.

21. *In contraria studia,* "into opposite desires" = "into opposing parties."

24. *Procul,* "from afar." He began to speak even before he reached the crowd.

26. *Sic notus.* The emphasis is on the adverb: "Is it in this way that Ulysses was known to you?"

27. *Aut hoc,* etc. Either the Greeks are shut within the horse, so that if we receive it, they will be admitted to our city; or it is an engine for scaling our walls, and would, therefore, be dangerous even if left outside.

29. *Urbi* = "on the city." The dative is used instead of the accusative with a preposition.

30. *Aut aliquis error* = "or some (other) guile lies hid." *Error* = "means of misleading," "deceit," "guile."

31. *Et* = "even." This expression has become proverbial for gifts offered by an enemy.

32 *Validis viribus* must be taken with *contorsit.*

33. *In latus inque alvum* probably means that the spear struck the side, and then penetrated through to the belly of the horse.

Curvam compagibus. "Bent with joints" = "jointed arch," as Conington translates.

34. *Illa* = *hasta.*

35. *Cavae,* in agreement with *cavernas,* should be taken in close connection with the verb *insonuere* = "gave a hollow echo."

36. *Si fata,* sc. *fuissent,* "if the Fates had so willed it." *Mens* = "the mind of man"—human action compared with divine agency.

37. *Impulerat.* The indicative is used vividly to express an unfulfilled hypothesis. "He had led (us) on to," etc.

39. *Agmine,* "column"—used of the movement of the snakes.

40. *Laocoonta.* This is the Greek form of the accusative singular of Laocoon, as the name is, of course, taken from the Greek.

43. *Auxilio,* probably a dative of purpose, "for help" = "to their help"

45. *Collo squamea circum terga dati.* *Collo* is the dative after *circumdati,* and *terga* is the accusative of respect after the passive participle; just as in l. 48 *vittas* is the accusative after *perfusus.*

46. *Cervicibus.* The plural *cervices* is regularly used to denote the "neck" (instead of the singular *cervix*).

48. *Vittas.* The fillets which he wore as a priest.

VERGIL.—IV.

The narrative of the destruction of Troy is continued throughout the second book of the "Æneid," while the third book is entirely devoted to the story of Æneas's wanderings by sea and land. The fourth book tells the tale of Dido's passion for Æneas, of her desertion by the hero in obedience to the will of the gods, and of Dido's tragic end.

The keynote of this dramatic episode is struck in the first lines of the book:—

"At regina, gravi jamdudum saucia cura,
Vulnus alit venis, et caeco carpitur igni"

"But the queen, wounded long ago by love's cruel shaft, feeds the wound with her life's blood, and is consumed with its hidden fire."

Dido confesses her new-born love to her sister Anna, but declares she will never yield to it nor prove unfaithful to her dead husband, Sychaeus.

Anna however suggests that the gods have brought Æneas to the shores of Africa, and that he is destined to aid her in the conquest of her savage neighbours:—

"His dictis incensum animum inflammavit amore,
Spemque dedit dubiae menti, solvitque pudorem."

"With these words she added fuel to the fire of love, gave hope to a doubting mind, and loosed the restraints of shame."

Thereon they offer sacrifice to the gods of marriage, and seek by means of omens to learn whether they favour the match:—

Heu vatum ignarae mentes! quid vota furentem,
Quid delubra juvant? Est molles flamma medullas
Interea, et tacitum vivit sub pectore vulnus.
Uritur infelix Dido, totaque vagatur
Urbe furens: qualis conjecta cerva sagitta,
Quam procul incautam nemora inter Cresia fixit
Pastor agens telis, liquitque volatile ferrum
Nescius: illa fuga silvas saltusque peragrat
Dictaeos; haeret lateri letalis arundo.
Nunc media Aenean secum per moenia ducit,
Sidoniasque ostentat opes, urbemque paratam;
Incipit effari, mediaque in voce resistit:
Nunc eadem, labente die, convivia quaerit,
Iliacosque iterum demens audire labores
Exposcit, pendetque iterum narrantis ab ore.
Post, ubi digressi, lumenque obscura vicissim
Luna premit, suadentque cadentia sidera somnos,
Sola domo moeret vacua, stratisque relictis
Incubat: illum absens absentem auditque videtque:
Aut gremio Ascanium, genitoris imagine capta,
Detinet, infandum si fallere possit amorem.
Non coeptae assurgunt turres; non arma juventus
Exercet, portusve aut propugnacula bello
Tuta parant: pendent opera interrupta, minaeque
Murorum ingentes, aequataque machina caelo.

The rival goddesses, Venus and Juno, swear a truce, and the nuptials of Æneas and Dido are celebrated. Then rumour spreads about—

"Fama, malum qua non aliud velocius ullum:
Mobilitate viget, viresque adquirit eundo."

"Rumour, speedier than any other monster, who nimbly moves, and gains strength as she goes."

The rumour reaches Iarbas, a rejected suitor of Dido's, who appeals to Jupiter, his father. Jupiter sends Mercury to warn Æneas that he must leave Carthage at once, and follow out his destiny. Æneas prepares to obey, and his fleet is made ready for sea. Dido hears of his faithless purpose, and thus assails him:—

"Dissimulare etiam sperasti, perfide, tantum
Posse nefas, tacitusque mea decedere terra?
Nec te noster amor, nec te data dextera quondam,
Nec moritura tenet crudeli funere Dido?
Quin etiam hiberno moliris sidere classem,
Et mediis properas Aquilonibus ire per altum,
Crudelis? Quid? si non arva aliena domosque
Ignotas peteres, et Troja antiqua maneret,
Troja per undosum peteretur classibus aequor?
Mene fugis? Per ego has lacrimas dextramque
tuam te,
Per conubia nostra, per inceptos hymenaeos,
Si bene quid de te merui, fuit aut tibi quidquam
Dulce meum: miserere domus labentis, et istam,
Oro, si quis adhuc precibus locus, exue mentem.
Quid moror? an mea Pygmalion dum moenia
frater
Destruat, aut captam ducat Gaetulus Iarbas?
Saltem, si qua mihi de te suscepta fuisset
Ante fugam suboles, si quis mihi parvulus aula
Luderet Aeneas, qui te tamen ore referret,
Non equidem omnino capta ac deserta viderer."

NOTES.

1. *Vatum ignarae mentes.* The reference seems to be general. The skill of seers could avail nothing. Dido's passion was beyond their art. "Who can minister to a mind diseased?"
2. *Est*, from *edo*, old form of the third person singular, present indicative.
3. *Tacitum*, "unconfessed;" *vivit*, "is kept alive." The same metaphor is found in the lines quoted above—*Vulnus alit venis.*
4. *Tota urbe.* The ablative of place where, if qualified by the adjective *totus* or *medius*, may be used without a preposition.
5. *Qualis* (lit., "of such a sort as"—i.e., "like as") introduces the simile. On Vergil's similes see a note on the second piece of Vergil set you. Here also the details, beautiful in themselves, contribute nothing to the comparison.
   Conjecta sagitta. "When the arrow has sped to its aim." *Conicere* is specially used of a weapon reaching its mark.
7. *Agens telis*, "chasing with his darts." One of them has reached its mark, but the shepherd knows it not (*nescius*), and therefore is unaware of his victim's sufferings. So Æneas knew not of Dido's passion.
8. *Illa* = *cerva.* The pronoun is often used in this way to mark emphatically a change of subject.
9. *Dictaeos* = Cretan, as Dicte is a mountain in Crete.
10. *Moenia.* The walls imply the city.
11. *Sidonias* = Carthaginian. Carthage was a Phœnician colony, and hence *Tyrius*, *Sidonius*, *Phoenicius* are all used to describe it.
    Urbem paratam. In contrast to Æneas's city, which was yet to be built. This would appeal to the weary Trojans.
13. *Eadem* might refer to Dido. It is better to take it in agreement with *convivia*, "the banquet of yesterday," as Conington translates it.
15. *Pendet ab ore* ("hangs on his lips") implies rapt attention.
16. *Digressi.* "The guests have gone."
17. *Suadentque*, etc. This phrase occurs also in the passage set on p. 261.
18. *Stratis relictis.* The couch where Æneas had been reclining.

19. *Absens absentem.* The repetition of the word is, strictly speaking, illogical, but increases the poetic effect.
20. *Ascanium.* This refers to another time, when Ascanius is with her in the absence of his father.
21. *Si possit* = "to try if she can." The condition does not logically refer to the governing verb *detinet*.
23. *Propugnacula bello tuta.* Lit., "fortifications safe in war."
24. *Minae murorum.* "Threatening walls."
26. *Dissimulare etiam.* *Etiam* implies "(not only to commit, but) even to conceal."
27. *Tacitus* is predicative, and is used like an adverb = "in silence."
28. *Data dextera.* "Thy plighted troth;" lit., "right hand given (to me)."
29. *Moritura,* "about to die"—i.e., "whom thou doomest to die;" qualified by *crudeli funere.* Dido had resolved to kill herself.
30. *Hiberno sidere,* "with wintry star"—*i.e.,* in winter time. From September to April navigation was almost entirely suspended by the Greeks and Romans, and anyone who put to sea in the winter was regarded as reckless.
32. *Si non arva,* etc. The argument is, even if he were going home, instead of to a foreign land, he would not take ship at such a season. *Undosum* is emphatic.
33. *Peteres . . . maneret.* The imperfect subjunctive is used to express an unfulfilled hypothesis.
35. *Per ego has lacrimas . . . te*—*i.e., Per has lacrimas ego te* (*precor*). The insertion of a word like *ego* between the preposition and its case is usual in entreaties. Here the verb of supplication is not expressed till l. 39 (*oro*).
36. *Inceptos* = begun but not finished. "Our nuptial rites yet incomplete."
37. *Quidquam.* *Quisquam* is generally only used in negative or interrogative sentences; it is sometimes found in conditional clauses.
38. *Labentis.* Genitive agreeing with *mei* understood.
Istam, "that of thine." *Iste* is often used = *tuus.*
40. *Quid moror?* "Why do I delay (to die)?" *An . . . dum.* The question is elliptical. "(Am I waiting) until," etc.
Pygmalion, brother of Dido, had slain her first husband, Sychaeus.
41. *Gaetulus Iarbas.* The African prince, Iarbas, was a rejected suitor of Dido's, from whom she might fear violent treatment.
42. *Suscepta,* "raised." It was usual for the father of a new-born child to recognise it as his own by lifting it from the ground (*tollere* or *suscipere*).
44. *Tamen* ("in spite of all"), a pathetic touch.

HISTORIC SKETCHES, GENERAL.—IX.

[*Continued from p. 204.*]

THE DUKE OF ALVA AND THE NETHERLANDS.

MANY a stout heart quailed, and many a brave man feared, in the cities of the Netherlands, when it was known there, towards the close of the year 1567, that Ferdinand Duke of Alva was coming with an army from Spain to assume the government of the provinces. Under the regency of the Duchess of Parma, daughter of their beloved Charles-Quint (Charles the Fifth, Emperor of Germany, King of Spain and the Indies, Duke of Burgundy and the Low Countries), they had lived contented enough, save that occasionally they complained of the number and weight of the taxes, and resented grumblingly any attack that was made upon their old commercial and municipal privileges. They adored the memory of Charles the Fifth, the grandson of their own Mary of Burgundy. Charles had dwelt among them, known to them as it were intimately, preferred to live in their country rather than in any other spot in his dominions, and ever got back to it again as soon as he could when the exigencies of public business took him out of it. His rule was kindly, though it did not brook rebellion, but then no one wanted to rebel against Charles-Quint. Under his rule the Netherlands were happy and flourishing, more so than they had been at any previous period of their history. When he abdicated in favour of his son, Philip II. (1556), and it was found that the new king intended to live in Spain, the Netherlanders thought themselves fortunate in having so Charles-Quint-like a resident ruler as Charles's daughter, the Duchess of Parma.

Notwithstanding that she was obliged, in order to carry out Philip's policy, which was much less liberal than his father's, to govern the people somewhat more sternly than they had been wont to be governed, the duchess was popular enough; and, as she had many ties of sympathy with the people, she was a guarantee to the Netherlands that so long as she ruled they would not be oppressed.

But the Duke of Alva! That was a very different matter. Although his name was not so famous, or infamous, as it became after he retired from the Low Countries, it was known to the people as that of a bigoted Spanish soldier, who had narrow ideas of his duty, but a tremendous energy in carrying out those ideas—as the name of one who made no secret that he considered his highest duty to God and man was to root out heresy wherever he had the chance, not stopping to criticise the means adopted, so the end were attained. Well might the Lowlanders fear when such a man was coming, with a numerous and well-appointed army at his back, to supersede the duchess-regent. They knew not what instructions he carried, what power his commission gave him, but they could read the signs of the times as well as any statesman in Europe, and they saw in Alva and the Spanish army nothing but oppression, and most likely bloodshed, to come. The political and municipal institutions of the country were far too free to be to the liking of an absolutist like the

King of Spain or his lieutenant, and the people feared lest assaults should be made upon these institutions accordingly. But still more they feared for what the new governor might bring against that freedom to worship God according to the dictates of their consciences which they had hitherto virtually enjoyed.

With very many of the Netherlanders the doctrines of the Reformation had found a cordial welcome, so that it is not perhaps exceeding the truth to say that one-third of their number were Protestants. Charles the Fifth, himself a rigid Catholic, half allowed, while he disapproved, the spread of the Reformation among his people. No persecuting measures had been taken to secure uniformity during his reign; and though the Catholics complained of toleration, and did what they could to stir up war against it, the Protestants were allowed to meet in their own places of worship. But now it was felt—and there had been several straws showing which way the wind was likely to blow—that all this was about to be changed. What had been attempted in France was to be attempted in the Netherlands, and, as it seemed, with much better chances of success. The Inquisition was to be imported as part of the baggage of the Spanish army, and the Protestants of the Low Countries were to be brought into slavery by it. In France, where the Huguenots numbered over two millions, and included among their ranks some of the most influential of Frenchmen, the attempts of the League—with its Guises, its Lorraines, and its Mayennes — to thrust the Inquisition upon the land, were met by a stubborn organisation of singularly brave men, who had moreover the countenance, and could procure the material support, of several foreign Powers, enemies to their enemies.

EXECUTION OF EGMONT AND HORN.

In the Netherlands there was not any such organisation, at least not then, nor was there, as it seemed, the slightest prospect of one being formed. It seemed at first sight that the provinces were utterly at the mercy of the Spaniards, men in whose composition the quality of mercy was left out—bigots, sincere in their bigotry, and cruel by their nature against everything that thwarted it. Only those whose trust was not in the arm of flesh only, who believed indeed that there was a God who judged the earth, One who could "mock the counsel of the wise and valour of the brave"—only such men did not despair. Long and bitter was the struggle, dark and frightful was the night, but with the morning came joy, albeit subdued, and the result of the struggle was to show the world once again that the victory is not always to the strong.

Alva came, the Duchess of Parma was superseded, and the worst fears of the Netherlanders were justified. Both in politics and religion their liberty

was to be taken away, and that by means which showed an almost brutal indifference to all their tenderest susceptibilities. The system of local self-government was changed for government by soldiers, troops were quartered in all the large towns, and the smaller places followed of necessity the example of submission into which their larger brethren were surprised. The Netherlands were occupied as a hostile country; the irresponsible prerogative of martial law was substituted for the known laws of the land; and the harshness and insolence of military commanders usurped on the judgment-seat the place of magisterial calmness and equity.

This was meant only as a foundation on which to build the hateful Inquisition. When the people were bound hand and foot by an army, it was supposed they might be made to accept this darling project of Philip. But there was a limit to the patience even of the Dutchmen and Belgians.* There was a line over which they could not be pushed without resistance; and when the people found that the Inquisition was among them, they rose in spite of the presence of the Spanish soldiery, so that throughout the provinces there was nothing but tumult. It was a state of things well pleasing to Alva, whose cruel disposition took delight in the prospect of dragooning the people into submission, of getting rid, by the way, of sundry inconvenient nobles, and at the same time of doing what his bigotry told him was a service acceptable to God, viz., the punishment and eradication of heresy.

Alva's powers were of the fullest. There was no need to send to Madrid for instructions, though reinforcements were demanded and sent. The risings which took place in most of the large towns were put down with Spanish cruelty; men were hanged summarily over their own doors; the prisons were not crowded, for the Spanish system was too "thorough" to be hampered with prisoners, its judicial procedure too simple to be fettered with a sliding scale of punishments according to offences, and so death got his due, and more; and there was mourning of widows and orphans wherever the Spanish officers set up their courts. These first risings were the expression of spontaneous, natural resistance to tyranny, not the result of organised rebellion. The Netherlanders formerly, under their counts and dukes, had been so tetchy and independent as to have acquired a notoriety in Europe as the most rebellious and unmanageable of subjects, and had dared on several occasions to provoke and resist the wrath of so hard and haughty a lord as Charles the Bold of Burgundy. But, under more judicious and larger-hearted government, especially that of their persecutor's father, they had forgotten the art of factiousness, and scarcely knew what it meant to rebel. Now they had to learn hurriedly, and in the face of cruel necessity, the long-disused science, and to unite heart and hand in a common cause, which was not only the cause of patriotism, but of humanity.

It was seen very clearly that unless a stop were put to, or at least a protest raised against, the policy of which the Duke of Alva was the exponent, both the name and form of political independence were gone, and the hitherto free Netherlanders must become the slaves of Spain. This fact brought over to the ranks of the malcontents even those who, being Catholics, might not have been disposed to stir against the Inquisition. The attempt to subvert civil liberty struck a chord in all hearts which vibrated right through the land. But most of the Catholics resented the Inquisition with nearly as much anger as the Protestants, the result being that every man, woman, and child in the Low Countries, with a few ignoble exceptions, was ready, from one motive or the other, to rebel against Alvaism. Remonstrants were treated as mutineers, deputations to Spain to beg the interference and protection of Philip were insulted and maltreated, and orders were given to the Duke of Alva to "quiet" the provinces.

The spirit of rebellion unguided, not concentrated but diffused, could only expose those in whom it dwelt to revengeful destruction, without in any way helping them to the goal they aimed at. Organisation, and some definite object to be gained through it—these were necessary to success; and for these the people looked, naturally enough, to the nobles, their countrymen, who lived among them, knew their ways and thoughts, and were thoroughly identified with themselves. At first the nobles held back. They were shy of entering upon an enterprise wherein the alternative of success—success against the power and resources of the mightiest empire in the world—were death for themselves and their followers, and ruin, thorough and complete, for their families. A few generous spirits, and a few with little save their own heads to lose, entered precipitately into the strife, and came promptly to an untimely end. But the great nobles, the men of influence and fortune, hesitated to guide the storm of their countrymen's indignation against the oppressors, until they were satisfied that nothing was to be got by other means, and until, when satisfied of that, things were

* The existing kingdoms of Holland and Belgium were at this time included in the Netherlands, of which there were seventeen provinces.

actually ready for the tremendous contest. There was no lack of patriotism, of self-denial, self-sacrifice, or personal courage in the Dutch, Flemish, and Brabant nobles, but they felt themselves constrained to hope, almost against hope, that so dreadful a sorrow as that which threatened would not be thrust upon their country. They felt it to be their duty, in spite of what was daily going on through Spanish instrumentality, to try—as the Long Parliament did in England before the Civil War—every constitutional means of easing the people's burdens before they committed themselves and the country to open war with the government. They tried and failed. The crafty Spaniard who governed pretended to lend an attentive ear to their remonstrances, and made a show of asking their advice, but he simply wanted to gain time, and to mature his plans for getting them into his net.

Greatest of all the noblemen in the provinces was the Prince of Orange, known in history as William the Silent. Of vast estates and fortune, second to none in rank, of extraordinary ability and indomitable will, he was eminently fitted to be the leader of his country. He was one of those who tried everything rather than rebellion to bring the Spaniards to their senses. He was the first to see that nothing but rebellion would do, the first who set seriously to work to organise and draw to a head that spirit of resistance which was rife throughout the country. Being a man who kept his own counsel, and who never made a feint till he was ready to strike, he succeeded in keeping clear of Alva's toils, though not of his suspicion. Convinced when he saw the Inquisition actually established, its victims of both sexes publicly burned by scores, whole townships ruthlessly butchered, in return for trivial signs of disaffection, and a reign of terror begun, that there could be but one end of it all, he kept out of the Spanish monster's way, and gave himself heart and soul to the cause which, but for him—unless a miracle had been wrought—must have perished miserably.

The spark which fired the train of every Netherlander's fury was the seizure, mock trial, and execution of Counts Egmont and Horn at Brussels. These noblemen fell victims to their own generous impetuosity, which led them, in the discharge of what they deemed to be their duty, to place themselves at the mercy—save the mark!—of the Duke of Alva. They were exceedingly popular, and in their blood was quenched the last spark of allegiance towards the Spanish king. Many merchants and skilled artisans left the country, and brought to England the wealth and industry which helped so materially to enlarge the commercial prosperity of that country during the time of Elizabeth; but there remained enough of willing hearts and strong bodies to bear the cause of the Prince of Orange stiffly up, and to resist even to death, and beyond the power of death, the wicked attempts of the Spaniards to tread down their brethren.

In 1572 William the Silent put himself at the head of the Beggars, as the insurgents were called, and gave the Spanish soldiers something else than unarmed burghers and defenceless women to practise on. Alva took the field, and made preparations on an extensive scale for crushing the rebellion; but his wary opponent, possessing an intimate knowledge of the country, and having the sympathies of all non-combatants—all the fighting men were with him—avoided any decisive actions, and practised his troops in skirmishes and small engagements with the enemy. Aware, however, of the importance of securing the sea-coast, in order to keep up his communications with England and to ensure supplies, he made a dash at Brille, captured it, and having fortified the place, immediately began fitting out cruisers to prey upon Spanish commerce.

The war went on with dreadful fury. The raw levies of the insurgents were no match in the open field for the splendidly trained troops of Spain, and they had more courage than discretion even in the defence of their besieged towns. The result was that the Netherlanders experienced defeat after defeat, each loss being followed up by barbarous executions of prisoners, and the captured towns being exposed to all the brutality of a licentious soldiery.

But no disaster could daunt the spirit of the Prince of Orange: bowed down though he was with the weight of cares and responsibilities, grieved and shocked for the sufferings which the rebellion had brought upon the people, he never gave way to despair. Quietly, doggedly, trustfully, he applied himself to his work, convinced of the righteousness of his cause, and willing to leave the issue in His hands with whom are all things. Generally defeated, he set the example which his descendant, William the Third of England, followed, of immediately showing front again, and of snatching from the enemy the fruits of victory. Alva fretted like a galled horse, but he could not make any impression. All his cruelty, all his cunning, all his energy went for nothing: he had found his master; and after two years spent in incessantly trying, with enormous means, to win back the revolted provinces, he was obliged to give up in despair, and return to Spain with the

(to him) grim satisfaction that during his term of office he had destroyed some 18,000 of the Netherlanders by public executions.

Requesens succeeded him, and after carrying on a desolating war for three years, during which the people of the provinces suffered horribly, he was obliged to come to terms with some of the states, eleven of which agreed for peace on condition of Alva's laws being repealed, all foreigners being expelled, and the power of the States-General being restored.

Don John of Austria, brother to Philip of Spain, succeeded Requesens, and artfully wrought upon the southern provinces to desert the northern by appealing to their anti-Protestant prejudices. The Prince of Orange knew what he was doing, and anticipated the result by forming in 1579, the Confederacy of Utrecht, which was the foundation of the Dutch Republic, known as the Republic of the United Provinces.

The war continued, the Belgians joining with the Spaniards, under the first generals of the age, to crush the Hollanders. The sufferings of the devoted people were horrible, but they never talked of surrender; they were often brimful of despair, but they never allowed it to find vent. In 1581 they offered the crown to the Duke of Anjou, brother of the French king, but he could not take it; then they offered it, in 1585, to Queen Elizabeth, who also declined, but she helped them with an army, in which Sir Philip Sidney fought and died, in which Walter Raleigh served, and which the Earl of Leicester commanded. In 1584, when the murder of William of Orange seemed to render the cause of the patriots utterly hopeless, the Hollanders gave Maurice, the dead man's son, the supreme command; and he, emulating the wisdom and valour of his father, strove so well, in conjunction with his English allies, that he beat back the oppressors of his country, weary and exhausted, and compelled Spain, in 1609, to acknowledge the independence of the Republic.

The other provinces which made peace with Spain remained to that power till 1714, when they were made over to the Austrian Habsburgs, who kept them till 1791. In that year the French annexed them, and they formed part of the empire till the overthrow of Napoleon. On that occasion they were added to the kingdom of Holland, with which they remained till 1830, when the existing kingdoms of Holland and Belgium were marked out and recognised.

See:—Cassell's Universal History; Motley, Rise of the Dutch Republic; United Netherlands.

GREEK.—V.

[Continued from p. 209.]

THE THIRD DECLENSION (*continued*).

I. NOUNS WHOSE STEM ENDS IN A CONSONANT (*continued*).

(*b*) *The Nominative has the short vowel of the stem lengthened, as compensation for lost* ς: e.g., ε *into* η, *and* ο *into* ω.

Stems in -ντ drop the τ in the nominative; as, λέων instead of λεοντ.

Singular.

	Shepherd.	*Divinity.*	*Lion.*	*Ether (air).*	*Speaker (orator).*
Nom.	ποιμήν.	δαίμων.	λέων.	αἰθήρ.	ῥήτωρ.
Gen.	ποιμέν-ος.	δαίμον-ος.	λέοντ-ος.	αἰθέρ-ος.	ῥήτορ-ος.
Dat.	ποιμέν-ι.	δαίμον-ι.	λέοντ-ι.	αἰθέρ-ι.	ῥήτορ-ι.
Acc.	ποιμέν-α.	δαίμον-α.	λέοντ-α.	αἰθέρ-α.	ῥήτορ-α.
Voc.	ποιμήν.	δαῖμον.	λέον.	αἰθήρ.	ῥῆτορ.

Plural.

N.V.	ποιμέν-ες.	δαίμον-ες.	λέοντ-ες.	αἰθέρ-ες.	ῥήτορ-ες.
Gen.	ποιμέν-ων.	δαιμόν-ων.	λεόντ-ων.	αἰθέρ-ων.	ῥητόρ-ων.
Dat.	ποιμέ-σι.	δαίμο-σι.	λέου-σι.	αἰθέρ-σι.	ῥήτορ-σι.
Acc.	ποιμέν-ας.	δαίμον-ας.	λέοντ-ας.	αἰθέρ-ας.	ῥήτορ-ας.

Dual.

N.A.V.	ποιμεν-ε.	δαίμον-ε.	λέοντ-ε.	αἰθέρ-ε.	ῥήτορ-ε.
G.D.	ποιμέν-οιν.	δαιμόν-οιν.	λεόντ-οιν.	αἰθέρ-οιν.	ῥητορ-οιν.

Δαήρ, *a husband's brother*, makes in the vocative δᾶερ; Ἀμφίων (-ονος) makes ὦ Ἄμφῖον; also Ἀγαμέμνων (-ονος), vocative Ἀγάμεμνον.

The following in -ων (-ονος) in some cases drop the ν and undergo contraction, like nouns with stem ending in ο or ω (for which *vide infra*):—εἰκών, *image*, genitive εἰκόνος, εἰκοῦς, accusative εἰκώ; ἡ ἀηδών, *the nightingale*, genitive ἀηδόνος, contracted into ἀηδοῦς, vocative ἀηδοῖ; ἡ χελῑδών, *swallow*, genitive χελῑδόνος, vocative χελῑδοῖ.

ADJECTIVES.

Examples of adjectives which follow the nouns of this class are—(1) ὁ, ἡ ἀπάτωρ, τὸ ἀπάτορ, *fatherless*, ἀμήτωρ, ἀμῆτορ, *motherless*, the genitive ends in -ορος; (2) ὁ, ἡ ἄῤῥην, τὸ ἄῤῥεν, *manly*. gen. ἄῤῥενος; (3) Adjectives in -ων (m. and f.) and -ον (n.), as ὁ, ἡ εὐδαίμων, τὸ εὔδαιμον. *happy*; and the comparatives in -ων, -ον; -ιων, -ιον. These comparatives, after dropping the ν, suffer contraction in the accusative singular, and in the nominative, accusative, and vocative plural. The vocative is the same as the nominative neuter, and shows the pure stem.

Singular.

	Happy. ὁ, ἡ	τὸ	*More hostile.* ὁ, ἡ	τὸ
Nom.	εὐδαίμων,	εὔδαιμον.	ἐχθίων,	ἔχθῑον.
Gen.	εὐδαίμονος.		ἐχθίονος.	
Dat.	εὐδαίμονι.		ἐχθίονι.	
Acc.	εὐδαίμονα,	εὔδαιμον.	ἐχθίονα (ἐχθίω),	ἔχθιον
Voc.	εὔδαιμον.		ἔχθῑον.	

Plural.

	Happy.		*More hostile.*	
	οἱ, αἱ	τὰ	οἱ, αἱ	τὰ
N.V.	εὐδαίμονες.	εὐδαίμονα.	ἐχθίονες	ἐχθίονα
			(ἐχθίους),	(ἐχθίω).
Gen.	εὐδαιμόνων.		ἐχθιόνων.	
Dat.	εὐδαίμοσι.		ἐχθίοσι.	
Acc.	εὐδαίμονας.	εὐδαίμονα.	ἐχθίονας	ἐχθίονα
			(ἐχθίους),	(ἐχθίω).

Greater.

Singular.			*Plural.*		
	ὁ, ἡ	τὸ		οἱ, αἱ	τὰ
Nom.	μείζων,	μεῖζον.	N.V.	μείζονες	μείζονα
				(μείζους),	(μείζω).
Gen.	μείζονος.		Gen.	μειζόνων.	
Dat.	μείζονι.		Dat.	μείζοσι	
Acc.	μείζονα	μεῖζον.	Acc.	μείζονας	μείζονα
	(μείζω).			(μείζους),	(μείζω).
Voc.	μεῖζον.				

Dual.

	Happy.	*More hostile.*	*Greater.*
N.A.V.	εὐδαίμονε.	ἐχθίονε.	μείζονε.
G.D.	εὐδαιμόνοιν.	ἐχθιόνοιν.	μειζόνοιν.

VOCABULARY.

Ἀγέλη, -ης, ἡ, a flock, herd.

Ἄδικος, -ον, unjust (α priv., and δίκη, justice).

Ἄνευ (genitive), without.

Γέρων, -οντος, ὁ, an old man.

Δῆμος, -ου, ὁ, the people (Latin *populus*).

Εἴκω (dative), yield;—τῆς ὁδοῦ, get out of the way of, give place to.

Ἡγεμών, -όνος, ὁ, a leader, general.

Θεραπεύω, I honour.

Κολαστής, -οῦ, ὁ, a punisher.

Λιμήν, -ένος, a harbour.

Ναίω, I inhabit, dwell.

Ὁδός, -οῦ, ἡ, a way.

Ὄλβιος, -α, -ον, happy.

Σώφρων, -ον (gen. -ονος), sound-minded.

Ὑπέρφρων, ὑπέρφρον (gen. -ονος), high-minded, too high-minded, proud (ὑπέρ, over).

Φρήν, -ενός (pl. φρένες), the heart, soul.

Φυλάττω, I watch, guard, keep.

EXERCISE 19.

Translate into English:—

1. Τὸν γέροντα θεράπευε. 2. Σέβου τοὺς δαίμονας. 3. Οἱ ποιμένες ἀγέλας φυλάττουσιν. 4. Τὸν κακὸν φεῦγε ὡς κακὸν λιμένα. 5. Ἄνευ δαίμονος ὁ ἄνθρωπος οὐκ ὄλβιός ἐστιν. 6. Ὁ θεὸς ἐν αἰθέρι ναίει. 7. Πολλάκις χαλεπαὶ μεριμναὶ τείρουσι τὰς τῶν ἀνθρώπων φρένας. 8. Ἕπου, ὦ φίλε, ἀγαθοῖς ἡγεμόσιν. 9. Εἶκε, ὦ νεανία, τοῖς γέρουσι τῆς ὁδοῦ. 10. Πολλάκις δῆμος ἡγεμόνα ἔχει ἄδικον νοῦν. 11. Ὁ θεὸς κολαστής ἐστι τῶν ἄγαν ὑπερφρόνων. 12. Ἔχε νοῦν σώφρονα. 13. Ὦ δαῖμον, πάρεχε τοῖς γέρουσι καλὴν εὐτυχίαν. 14. Οἱ θηρευταὶ τοὺς λέοντας ἀνθρεύουσιν.

EXERCISE 20.

Translate into Greek:—

1. Good boys honour old men. 2. Old men are honoured by good boys. 3. Sound-minded young men give place to old men. 4. Follow, O friends, a good leader. 5. We have good leaders. 6. The people often follow bad leaders. 7. God affords prosperity to the sound-minded. 8. Lions are hunted by huntsmen. 9. We worship the divinity.

To the previous examples belong the following substantives in -ηρ: namely, ὁ πατήρ, the father; ἡ μήτηρ, the mother; ἡ θυγάτηρ, the daughter; ἡ γαστήρ, the belly; ἡ Δημήτηρ, Demeter (*Ceres* in Latin); and ὁ ἀνήρ, the man; differing, however, from them in the omission of ε in the genitive and dative singular and in the dative plural; also in the interposition of α before -σι of the dative plural, in order to soften the sound. The word ἀνήρ (stem ἀνερ), throws away the ε in all the cases of the three numbers, except the vocative singular, and for the sake of sound introduces a δ, as appears from this tabular view:—

Singular.

Nom.	πατήρ.	μήτηρ.	θυγάτηρ.	ἀνήρ.
Gen.	πατρ-ός.	μητρ-ός.	θυγατρ-ός.	ἀνδρ-ός.
Dat.	πατρ-ί.	μητρ-ί.	θυγατρ-ί.	ἀνδρ-ί.
Acc.	πατέρ-α.	μητέρ-α.	θυγατέρ-α.	ἄνδρ-α.
Voc.	πάτερ.	μῆτερ.	θύγατερ.	ἄνερ.

Plural.

N.V.	πατέρ-ες.	μητέρ-ες.	θυγατέρ-ες.	ἄνδρ-ες.
Gen.	πατέρ-ων.	μητέρ-ων.	θυγατέρ-ων.	ἀνδρ-ῶν.
Dat.	πατρ-ά-σι.	μητρ-ά-σι.	θυγατρ-ά-σι.	ἀνδρ-ά-σι.
Acc.	πατέρ-ας.	μητέρ-ας.	θυγατέρ-ας.	ἄνδρ-ας.

Dual.

N.A.V.	πατέρ-ε.	μητέρ-ε.	θυγατέρ-ε.	ἄνδρ-ε.
G.D.	πατέρ-οιν.	μητέρ-οιν.	θυγατέρ-οιν.	ἀνδρ-οῖν.

NOTE.—*The accentuation of words of this class is very irregular.*

The word ἀστήρ, -έρος, *a star*, which otherwise retains the ε of the stem, belongs to this class, having its dative plural in ἀστράσι.

VOCABULARY.

Ἆθλον, -ου, τό, a prize gained in the public games.

Δουλεύω, I am a slave, I serve.

Ἐχθαίρω, I hate.

Περσεφόνη, -ης, ἡ, Persephonê (*per-sef'-o-ne*), Proserpine.

Σοφός, -ή, -όν, wise.

Στέργω, I love.

Χαίρω (dative), I rejoice at, delight in.

Χαρίζομαι, I show favour, gratify.

EXERCISE 21.

Translate into English :—

1. Στέργετε τὸν πατέρα καὶ τὴν μητέρα. 2. Μὴ δούλευε τῇ γαστρί. 3. Χαῖρε, ὦ φίλε νεανία, τῷ ἀγαθῷ πατρὶ καὶ τῇ ἀγαθῇ μητρί. 4. Μὴ σὺν κακῷ ἀνδρὶ βουλεύου. 5. Δήμητρι πολλοὶ καὶ καλοὶ νεῴ ἦσαν. 6. Ἡ ἀγαθὴ θυγάτηρ ἡδέως πείθεται τῇ φιλῇ μητρί. 7. Οἱ ἀγαθοὶ ἄνδρες θαυμάζονται. 8. Πολλάκις ἐξ ἀγαθοῦ πατρὸς γίγνεται κακὸς υἱός. 9. Ἐχθαίρω τὸν κακὸν ἄνδρα. 10. Τοῖς ἀγαθοῖς ἀνδράσι λαμπρὰ δόξα ἕπεται. 11. Ἡ Δήμητρος θυγάτηρ ἦν Περσεφόνη. 12. Ὦ φίλη θύγατερ, στέργε τὴν μητέρα. 13. Ἡ ἀρετὴ καλὸν ἆθλόν ἐστιν ἀνδρὶ σοφῷ. 14. Οἱ ἀγαθοὶ υἱοὶ τοὺς πατέρας καὶ τὰς μητέρας στέργουσιν. 15. Οἱ Ἕλληνες Δημήτερα σέβονται. 16. Πείθεσθε, ὦ φίλοι νεανίαι, τοῖς πατράσι καὶ ταῖς μητράσιν. 17. Χαρίζου, ὦ φίλε πάτερ, τῇ ἀγαθῇ θυγατρί.

EXERCISE 22.

Translate into Greek :—

1. O young men, love your father and mother. 2. Good daughters obey their (the) father and mother. 3. The citizens worship Ceres. 4. Persephone follows Ceres. 5. We admire the star. 6. O huntsmen, be not slaves to the belly. 7. A good mother loves a good daughter. 8. O mother and father, love your children. 9. The man is hated. 10. They hate the man. 11. They obey wise men. 12. I follow Ceres. 13. Often bad sons are born from a good father and mother.

Note that the Greek article has frequently the force of an English possessive pronoun, when, from the nature of the sentence, no mistake as to the meaning can arise. Consequently, in such cases, when you translate into English, give the possessive pronoun for the Greek article, and when you translate into Greek, give the article for the possessive pronoun.

(*c*) *The* NOMINATIVE *retains the original case-suffix* -σ.

(i.) Nouns whose stem ends in a *p* sound, or in a *k* sound; that is, in either -β, -π, -φ, or in -γ, -γγ, -κ, -χ. These form the nominative by simply adding *s* to the stem without any modification. (Observe that σ with a *p* sound makes ψ; and with a *k* sound, ξ).

Singular.

	Hurricane.	*Raven.*	*The gullet (throat).*
Nom.	ἡ λαῖλαψ.	ὁ κόραξ.	ὁ λάρυγξ.
Gen.	λαίλᾰπ-ος.	κόρᾰκ-ος.	λάρυγγ-ος.
Dat.	λαίλᾰπ-ι.	κόρᾰκ-ι.	λάρυγγ-ι.
Acc.	λαίλᾰπ-α.	κόρᾰκ-α.	λάρυγγ-α.
Voc.	λαῖλαψ.	κόραξ.	λάρυγξ.

Plural.

Nom.	λαίλᾰπ-ες.	κόρᾰκ-ες.	λάρυγγ-ες.
Gen.	λαιλάπ-ων.	κοράκ-ων.	λαρύγγ-ων.
Dat.	λαίλαψ-ι.	κόραξ-ι.	λάρυγξ-ι.
Acc.	λαίλᾰπ-ας.	κόρᾰκ-ας.	λάρυγγ-ας.
Voc.	λαίλᾰπ-ες.	κόρᾰκ-ες.	λάρυγγ-ες.

Dual.

N.A.V.	λαίλᾰπ-ε.	κόρᾰκ-ε.	λάρυγγ-ε.
G.D.	λαιλάπ-οιν.	κοράκ-οιν.	λαρύγγ-οιν.

Here belong the adjectives in -ξ (gen. -γος, -κος, -χος) and -ψ (gen. -πος), as ὁ, ἡ ἅρπαξ, -ᾰγος (Latin *rapax*, English *rapacious*); ὁ, ἡ ἧλιξ, -ικος (*æqualis*), *of the same age*: ὁ, ἡ μώνυξ, -ῠχος, *one-hoofed, having solid hoofs* (μόνος, *alone, one*, and ὄνυξ, *a hoof*); and ὁ, ἡ αἰγίλιψ, -ῖπος, *lofty*.

VOCABULARY.

Ἀγών, -ῶνος, ὁ, a contest in the public games.
Ἀθηναῖος, ὁ, an Athenian.
Αἴξ, αἰγός, ἡ, a she-goat.
Ἀλεκτρύων, -ονος, ὁ, a cock.
Δέ, but; μὲν—δέ, particles denoting a contrast.
Ἐλαύνω, I drive.
Ἵππος, -ου, ὁ, a horse.
Καὶ—καί, both—and.
Κόλαξ, -ᾰκος, ὁ, a flatterer.
Κρώζω, I croak.
Μάστιξ, -ῖγος, ἡ, a whip, scourge.
Μύρμηξ, -ηκος, ὁ, the ant.
Ὄρτυξ, -ῠγος, ὁ, a quail.
Ὀρχηθμός, -ου, ὁ, a dance.
Ὄψ, ὀπός, ἡ, voice (Latin *vox*).
Πολύπονος, -ον, laborious.
Σῦριγξ, -ιγγος, ἡ, a shepherd's pipe, Pandean (from the rural divinity, Pan) pipes.
Τέττιξ, -ῖγος, ὁ, the grasshopper.
Φέναξ, -ᾱκος, ὁ, a deceiver.
Φόρμιγξ, -ιγγος, ἡ, the harp.
* Ὠιδή, -ης, ἡ, song, ode (from ᾄδω, *I sing*).
Ὤψ, ὠπός, ἡ, the countenance, fair.

EXERCISE 23.

Translate into English :—

1. Οἱ κόρακες κρώζουσιν. 2. Τοὺς κόλακας φεῦγε. 3. Ἀπέχου τοῦ φένᾱκος. 4. Οἱ ἄνθρωποι τέρπονται φόρμιγγι καὶ ὀρχηθμῷ καὶ ᾠδῇ. 5. Οἱ ἵπποι μάστιγιν ἐλαύνονται. 6. Αἱ φόρμιγγες τοὺς τῶν ἀνθρώπων θύμους τέρπουσιν. 7. Τέττιξ μὲν τέττιγι φίλος, μύρμηκι δὲ μύρμηξ (sc. † ἐστίν). 8. Οἱ ποιμένες ὑπὸ τῶν συρίγγων ᾄδουσιν. 9. Παρὰ τοῖς Ἀθηναίοις καὶ ὀρτύγων καὶ ἀλεκτρυόνων ἀγῶνες ἦσαν. 10. Οἱ ποιμένες τὰς τῶν αἰγῶν ἀγέλας εἰς τοὺς λειμῶνας ἐλαύνουσιν. 11. Μυρμήκων καὶ ὀρτύγων βίος πολύπονός ἐστιν. 12. Πολλοὶ ἀγαθὴν μὲν ὦπα, κακὴν δὲ ὦπα ἔχουσιν.

* The *iota*, which is *subscript* with small letters, is written *by the side* of capitals, but not sounded. Thus ᾠδή becomes Ὠιδή, and ᾄδω becomes Ἄιδω.

† Note, *sc.* stands for *scilicet* (that is, *scire licet*), and points out that a word is understood, that is, left out, and is to be supplied; *sc.* is, therefore, equivalent to our *that is*, or *supply*; so here, *sc.* ἐστίν means that the verb ἐστί, *is*, being omitted by the author, must be supplied by the reader.

Exercise 24.

Translate into Greek:—

1. I avoid a flatterer. 2. Ravens croak. 3. You are delighted by the harp. 4. Dances delight men. 5. They drive the horses with (dat.) a whip. 6. The minds of men are led by the harp. 7. The pipe (plural) delights shepherds. 8. The she-goats are driven to the meadow. 9. The shepherd sings to the pipe. 10. The daughter has a beautiful face, but a bad voice.

(II.) Nouns whose stem ends in a *d* or *t* sound—that is, in either -δ, -τ, -κτ, -θ, or -νθ. These lose the last consonant of the stem in the nominative. The nouns in the ensuing table are: ἡ λαμπάς (instead of λαμπαδς), *a torch*: ἡ κόρυς (instead of κορυθς), *a helmet*; ὁ, ἡ ὄρνις (ορνιθς), *a bird*: ὁ ἄναξ (ανακτς), *a king*; and ἡ ἕλμινς (ἑλμινθς), *a tapeworm*.

Singular.

Nom.	λαμπάς.	κόρυς.	ὄρνις.	ἄναξ.	ἕλμινς.
Gen.	λαμπάδ-ος.	κόρυθ-ος.	ὄρνιθ-ος.	ἄνακτ-ος.	ἕλμινθ-ος.
Dat.	λαμπάδ-ι.	κόρυθ-ι.	ὄρνιθ-ι.	ἄνακτ-ι.	ἕλμινθ-ι.
Acc.	λαμπάδ-α.	κόρυν.	ὄρνιν.	ἄνακτ-α.	ἕλμινθ-α.
Voc.	λαμπάς.	κόρυς.	ὄρνις.	ἄναξ.	ἕλμινς.

Plural.

Nom.	λαμπάδ-ες.	κόρυθ-ες.	ὄρνιθ-ες.	ἄνακτ-ες.	ἕλμινθ-ες.
Gen.	λαμπάδ-ων.	κορύθ-ων.	ὀρνίθ-ων.	ἀνάκτ-ων.	ἑλμίνθ-ων.
Dat.	λαμπά-σι.*	κόρυ-σι.*	ὄρνι-σι.*	ἄναξ-ι.*	ἕλμι-σι.*
Acc.	λαμπάδ-ας.	κόρυθ-ας.	ὄρνιθ-ας.	ἄνακτ-ας.	ἕλμινθ-ας.
Voc.	λαμπάδ-ες.	κόρυθ-ες.	ὄρνιθ-ες.	ἄνακτ-ες.	ἕλμινθ-ες.

Dual.

N.A.V.	λαμπάδ-ε.	κόρυθ-ε.	ὄρνιθ-ε.	ἄνακτ-ε.	ἕλμινθ-ε.
G.D.	λαμπάδ-οιν.	κορύθ-οιν.	ὀρνίθ-οιν.	ἀνάκτ-οιν.	ἑλμίνθ-οιν.

The noun ὁ, ἡ παῖς (gen. παιδός), *child*, has in the vocative παῖ.

Here belong the adjectives in -ις and -ι (gen. -ιδος, -ῐτος), as ὁ, ἡ εὔχαρις, τὸ εὔχαρι (gen. -ῐτος), *pleasing, graceful*: also those in -ας (gen. -ᾰδος), as ὁ, ἡ φυγάς (gen. φυγάδ-ος), *an exile*, or *banished person*: those, too, in -ης (gen. -ητος), as ὁ, ἡ ἀργής (gen. -ῆτος), *white*; those, moreover, in -ως (gen. -ωτος), as ὁ, ἡ ἀγνώς (gen. ἀγνῶτος), *unknown*; and those in -ις (gen. -ιδος), as ὁ, ἡ ἄναλκις (gen. ἀνάλκιδος), *without strength*: ἡ πάτρις (sc. γῆ, *land*), gen. πάτριδ-ος, *one's native country*; finally, those in -υς (gen. υδος), as ὁ, ἡ νέηλυς (gen. νεήλυδος), *recently come*.

Vocabulary.

Ἀδελφή, -ῆς, ἡ, a sister.

Ἀδελφός, -οῦ, ὁ, a brother.

Ἅπας, ἅπασα, ἅπαν [ἁ, giving the force of *together* (ἁ from ἅμα, *together*)], all together, so of combination.

Ἀπορία, -ας, ἡ, want of means, destitution, need.

Γέλως, -ωτος, ὁ, laughter.

Ἐγείρω, I stir up, arouse, awaken.

Ἐλπίς, ἐλπίδος, ἡ, hope.

Ἐνεγείρω (ἐγείρω with ἐν, which in this case acts as an *intensive*: that is, it strengthens the force of the verb).

Ἔρις, ἔριδος, ἡ, strife.

Ἔρως, -ωτος, ὁ, love (Eng. *erotic*, as in "erotic poems").

Κακότης, -ητος, ἡ, baseness.

Κατακρύπτω, I conceal.

Κολάζω, I punish, chastise.

Κοῦφος, -η, -ον, light, light-minded.

Μακαρίζω, I account happy, congratulate.

Νεότης, -ητος, ἡ, youth.

Νύξ, νυκτός, ἡ, night.

Ὁμοιότης, -ητος, ἡ, likeness, resemblance.

Παῖς, παιδός, ὁ, ἡ, a child, son, daughter.

Πᾶς, πᾶσα, πᾶν, every; in the plural, πάντες, all.

Πένης, πένητος, ὁ, ἡ, poor.

Πλούσιος, -α, -ον, rich.

Πλοῦτος, -ου, ὁ, wealth.

Φιλοχρημοσύνη, -ης, ἡ, love of money, avarice.

Φρόντις, -ῐδος, ἡ, care.

Χάρις, -ῐτος, ἡ, loveliness, pleasingness, favour, benefit, gratitude (Latin *gratia*, English *gratis*).

* Instead of λαμπάδσι, κόρυθσι, ὄρνιθσι, ἄνακτσι, and ἕλμινθσι.

Exercise 25.

Translate into English:—

1. Οἱ ὄρνιθες ᾄδουσιν. 2. Χάρις χάριν τίκτει, ἔρις ἔριν. 3. Μακαρίζομεν τὴν νεότητα. 4. Ἀπορία τίκτει ἔριδας. 5. Πλούσιοι πολλάκις τὴν κακότητα πλούτῳ κατακρύπτουσιν. 6. Ὦ καλὲ παῖ, στέργε τὸν ἀγαθὸν ἀδελφὸν καὶ τὴν καλὴν ἀδελφήν. 7. Ἡ φιλοχρημοσύνη μήτηρ κακότητος ἁπάσης ἐστίν. 8. Οἱ πένητες πολλάκις εἰσὶν εὐδαίμονες. 9. Ἡ σοφία ἐν τοῖς τῶν ἀνθρώπων θύμοις θαυμαστοὺς τῶν καλῶν ἔρωτας ἐνεγείρει. 10. Ὁ θάνατος τοὺς ἀνθρώπους φροντίδων ἀπολύει. 11. Ἡ φιλία διὰ ὁμοιότητος γίγνεται. 12. Οἶνος ἐγείρει γέλωτα. 13. Ἐν νυκτὶ βουλὴ τοῖς σοφοῖς γίγνεται. 14. Οἱ σοφοὶ κολάζουσι τὴν κακότητα. 15. Οἱ ἄνθρωποι πολλάκις κούφαις ἐλπίσι τέρπονται.

Exercise 26.

Translate into Greek:—

1. Birds sing. 2. Favour is begotten by favour, strife by strife. 3. By (dat.) wisdom (there) is awakened in men's minds a wonderful love of good things. 4. I am delighted with the song of birds. 5. The songs of birds delight the shepherd. 6. We delight in (dat.) birds. 7. Men follow kings. 8. Men obey the king.

Key to Exercises.

Ex. 11.—1. Pursue honourable deeds, O beloved youth. 2. Obey the words of thy teacher. 3. Thou learnest excellent things from the excellent. 4. A faithful friend partakes of (your) good and (your) bad things (fortunes). 5. The gods care for men. 6. Men worship the gods. 7. Danger attends many works. 8. Good things are mixed with bad. 9. The bad man is hostile to (at enmity with) gods and men. 10. Men rejoice in good (men or things). 11. O God, grant good fortune (happiness) to our friends. 12. O slave, bear the wine to the young man. 13. Wine does not dissipate, but begets cares. 14. Glory follows a difficult achievement.

Ex. 12.—1. Οἱ ἀγαθοὶ τῷ Θεῷ πείθονται. 2. Οὐ πείθονται τῷ Θεῷ οἱ κακοί. 3. Πείθεσθε, ὦ καλοὶ νεανίαι, τῷ διδασκάλῳ. 4. Οἱ κακοὶ τοῖς ἀγαθοῖς ἐχθροί εἰσιν. 5. Τῶν κακῶν ἀπέχου. 6. Οἱ ἐσθλοὶ τῶν παίδων ἐπιμέλονται (φροντίζουσι). 7. Μὴ τῷ ψεύστου λόγῳ πίστευε, ὦ φίλε παῖ. 8. Πολλοῖς λόγοις ἕπονται κίνδυνοι. 9. Οἱ ἐσθλοὶ νεανίαι τοὺς διδασκάλους θεραπεύουσιν.

Ex. 17.—1. Avoid wild beasts. 2. A hand washes a hand. 3. Keep from the insect. 4. The meadows bloom. 5. The soldiers sing their war song. 6. We know (try) gold and silver in (by) fire. 7. Many become friends at the goblet (over their cups), but most (a greater number become) enemies. 8. Men are delighted with the harp and banqueting and dances and

Fig. 6.

songs of victory. 9. The Greeks worship Apollo and Poseidon (Neptune). 10. Industrious scholars read the works of the Greeks with pleasure.

Ex. 18.—1. Virtue, not time, is the measure of life. 2. Death liberates men from labours and evils. 3. Wine rejoices the minds of men. 4. With ten thousand (*i.e.*, countless) labours noble things are produced. 5. The divinity conducts the bad to judgment. 6. A faithful friend in a difficult division (strife) is worth silver and gold. 7. There are many diseases among men. 8. Counsel leads to good. 9. Silence brings honour to a youth. 10. The door is shut by bars. 11. Art nourishes men. 12. O beloved disciples (scholars), strive after wisdom and virtue.

Ex. 14.—1. Τῷ θανάτῳ ἀπολύονται τῶν κακῶν οἱ ἄνθρωποι. 2. Τῷ βίῳ πολλοὶ πόνοι ἕπονται. 3. Ἡ τοῦ θείου σοφία πρὸς εὐδαιμονίαν τοὺς ἐσθλοὺς ἄγει. 4. Τοῖς τοῦ κριτοῦ λόγοις ἕπου. 5. Οἱ τοῦ νέου λόγοι εἰσὶ κακοί. 6. Ἡ λύρα τὰς τοῦ θύμου μερίμνας λύει. 7. Νέῳ προσήκει ἡ ἡσυχία. 8. Τοὺς ἀγαθοὺς τρέφει ἡ τέχνη. 9. Ὁ μοχλὸς κλείει τὴν θύραν.

Ex. 15.—1. Temples are built to the gods. 2. It is not easy to walk on ropes. 3. We hunt hares. 4. Androgeus was the son of Minos. 5. Hares are hunted by huntsmen. 6. Pray to the merciful God. 7. Eagles capture hares. 8. Reverence the merciful divinities. 9. The brave receive deathless praise. 10. Pray that you may have (find) God merciful. 11. The gods are propitious to the good. 12. Pleasures lead away most people captive.

Ex. 16.—1. Τοῖς θεοῖς νεὼς κτίζεις. 2. Κτίζονται νεῴ τοῖς θεοῖς. 3. Νεὼν τῷ Θεῷ κτίζω. 4. Ἐπὶ κάλων βαίνουσι. 5. Τοὺς λαγὼς θηρεύομεν. 6. Οἱ λαγῴ θηρεύονται. 7. Οἱ Σάμιοι καλοὺς νεὼς ἔχουσι. 8. Τὸν ἵλεων Θεὸν σέβονται. 9. Ὁ Θεὸς ἵλεώς ἐστι τοῖς ἀγαθοῖς. 10. Οἱ θηρευταὶ θηρεύουσι τοὺς λαγώς. 11. Ὁ Μενέλεως λαμβάνει ἀγήρων ἔπαινον.

Ex. 18.—1. Φεῦγε τοὺς θῆρας. 2. Θῆρα φεύγουσι. 3. Τὰς χεῖρας νίζε. 4. Ἀπέχεσθε τῶν ψηνῶν. 5. Στρατιώτης τῷ παιᾶνι τέρπεται. 6. Ὁ παιὰν τοὺς στρατιώτας τέρπει. 7. Ὦ σπουδαῖοι μαθηταί, τὰ τοῦ Πλάτωνος βιβλία ἀναγιγνώσκετε. 8. Τὰ τῶν Ἑλλήνων βιβλία ἀναγιγνώσκεται ὑπὸ τῶν σπουδαίων μαθητῶν. 9. Τερπόμεθα τοῖς καλοῖς λειμῶσι. 10. Οἱ λειμῶνες θάλλουσι. 11. Οἱ ποιηταὶ τὸν Ἀπόλλω σέβονται. 12. Τὸν Ποσειδῶ σέβεται ὁ ποιητής.

WATER-COLOUR DRAWING.—III.

[*Continued from p. 220.*]

TREATMENT OF HIGH LIGHTS, ETC.

WE promised in the first lesson to take up again the method of producing or picking out high lights; we resume the subject in order to show how in sepia drawings brilliant and harmonious effects may be obtained by tinting the whole paper first with a moderate tone of sepia, then painting the subject upon it, and afterwards rubbing out the high lights with india-rubber. Many artists use Chinese white for the same purpose; this pigment is very durable, but must be used with judgment; it frequently requires the addition of a

light tone, either cool or warm as the case may be, to make it harmonise with the ground upon which it is laid: otherwise it will have a chalky effect. Being an opaque medium, it is of great advantage when employed with colours; sometimes the Chinese white is useful for preparing a fresh ground to receive a second painting with purer colour. Sometimes figures and cattle are painted with white after the picture is finished, the colours being mixed with the white, or the whole made

Fig. 7.

colouring tint is mixed with the white before it is used, or else the white is laid on the picture in its pure state, and then, when dry, a very light glaze or wash is passed over it, composed of Indian yellow and yellow ochre, or either of these alone, according to the tone of the surrounding parts near which it is laid. If a sepia drawing is made upon a grey paper, the white may be used alone. These remarks refer more especially to the brightest and most prominent lights; therefore we wish it to be understood that we do not intend here to include the broad lights, those parts which receive the general rays of the sun or any other luminary, but only those brilliant or sparkling effects which emanate with greater force from the projecting parts of polished surfaces, such as metal and glass; we may also include the reflection of light upon water and the masses of light clouds. To use Chinese white properly, and to prevent a flat and heavy appearance, it must be judiciously disposed, for if too liberally spread about the picture, the result will be a series of spots which destroy breadth and repose. Again, when any portion of the broad lights have become dirty through frequent washing, out with white, and the colours glazed or washed over it.

We recommend our pupils to try the method of rubbing out the lights first upon a sepia drawing; there will be no difficulty afterwards in applying the same process to a coloured one. When, with regard to colours, the other method—that is, the use of white as a body colour—is employed, the previous remarks will sufficiently explain all that is necessary for the use of it.

First, the sepia drawing (Fig. 6). Draw the outline first upon white paper, and determine the extent of the picture by ruling lines for a boundary. Then with a middle tint of sepia cover the whole within the boundary lines, commencing at the top, the picture being placed in an inclined position the outline must not be heavily drawn, it should be faintly but sufficiently seen through the sepia; the drawing must be very correct, as the wash of sepia will set the pencil marks so that it will be difficult to erase them for alterations. Commence the arrangement of the foreground with the same colour with which the paper was covered—that is, make out the grassy slope of the bank, with

all its broken details, above AA; the execution must be in short, sharp, careful touches to give character to the herbage, the brush being held in an upright position, so as to have a thorough command of the point, and power of moving it in any direction; draw the brush across the darker parts of the water, to represent the reflections of the trees; paint in the masses of the trees, especially the lights, being very particular that their forms are carefully preserved; observe the same with regard to the wall—that is, go round it close to its edges, and introduce some of the principal tones upon its surface; all this is to be done with the colour left after the paper was tinted. Our object in using the same tint is to give a little more time and attention to the arrangement of particulars; as it is light, no very great injury can be done, and the forms and drawing generally may be greatly improved; it also provides a semi-tone for many of the details, which may afterwards be left as the work progresses, by introducing the darker parts about them. Now make the colour a little darker, and put in the broad masses of shadow, viz., those about the semi-lights which were left with the last tint, to give them relief. Make the first tint a little lighter, and paint in the distance; at the same time break it about on the road and on some of the lightest parts of the water, leaving the light side of the post and its reflection. Increase the strength of the colour, and make out the darker particulars of the trees at *c*, also the broad masses of the large tree, and give a few additional touches to the bank and surface of the water. Care must be observed that all the lighter forms, not necessary to be rubbed, are left, and the pupil must be particularly careful to preserve the character of the drawing, by which we mean a close and studied attention to form throughout, such as the projecting branches of the tree at *d*, portions of the foreground, and similar places upon which light falls. We will now rub out the lights in the sky and on the water; use a well-pointed brush, perfectly clean, and not too wet; commence with the water by drawing it horizontally over those parts which are to have the greatest brilliancy (do a small portion at a time); after waiting a moment or two, to allow the wet to sink a little into the coloured ground, press it with the blotting paper, and rub the parts wetted with a piece of india-rubber or stale bread-crumb sharply and in the direction in which they are damped; also in the same way rub out the forms of the light clouds, and afterwards with a light tint make out their shadows on the under parts away from the sun. By this method of treating the high lights, we gain more transparency and atmosphere than can be obtained by the use of Chinese white, which is so liable to make the effect heavy and "painty." Lastly, all the darkest parts may now be attended to, by commencing with the dark tall tree, and bringing down the colour with sharp bright touches on the wall, the sides of the posts, the lines on the road, and the details of the foreground. The iron railings on the wall are to be left, by which we mean *the tone of the trees to be seen through the bars* is to be painted. If at any time the pupil should put on a tone or colour too dark, or too brilliant for its position, it is easily taken up with the blotting paper before it is allowed to become dry.

We will now endeavour to give an exposition of the process of painting the same subject in colours. In undertaking this we acknowledge the difficulty we have to contend with, in stating the exact gradations and strength of the tints. However minute we may be in our explanation, there will still be much that must be left to the judgment of the pupil. His first attempts will probably in many respects be exaggerated—that is, he may through his inexperience begin the picture with too powerful tints—some may be too hot, some too cold; but there will be no cause for discouragement if he should make such mistakes, so long as he recognises them and sees the side upon which he has erred—in short, he must expect to fail; but there is this encouragement accompanying failures, that when they are understood they will gradually become less frequent; *it is those who cannot perceive their faults who never improve.* As we can only give principles even whilst expounding the minutest details, we depend upon our pupil's persevering practice of those principles which must eventually produce results terminating in success. Should he, for instance, commence by making his sky too blue, he can sponge it out (it must be done without much rubbing, or he will destroy the surface of his paper), and try again; probably the colour left after the sponging will be sufficiently near the mark: the same observation may be made and applied where there is any other similar mistake in the picture. We advise him then, at first, to begin lightly, as the same parts can easily be gone over again with another careful wash; not to be in a hurry, and especially attend to the drawing. Thus, after a few repeated trials, he will soon begin to see his way, and discover that the tints he mixes in his experiments are without difficulty recognised in Nature; afterwards he will proceed with greater confidence, and apply them to the several parts of his picture at once, up to their proper strength, until at length he will make his picture his palette by uniting the requisite colours, taken fresh from the box,

in their proper places while wet, or by glazing the pure colours over one another when the under colours are dry.

We particularly advise the pupil to paint the subject of this lesson in sepia first, according to the previous instructions: he is little aware how much he will gain by it in the execution, and how greatly his judgment will be improved; he will thus be better prepared to imitate the depths and tones with the colours. Place the paper on an inclination, and commence from A A (Fig. 6) with a moderate tint of cobalt blue, making it a gradated tint towards the horizon as far as B B; if it is not intended to rub out the light clouds, as explained in the sepia drawing, they must be left by dragging the blue colour loosely, having regard to the forms of the clouds, over that part of the sky where they are situated; pass the same colour over the water; when dry, wash a light tint of yellow ochre over the road, the wall, the banks on both sides of the river, and over the lights of the tree—the distance must not be touched with this colour. When the sky is dry, mix a tint of cobalt, a little lake, and very little sepia for a grey with which to paint the clouds; add a little more cobalt and lake to the last tint, and make out the principal shadows and darker details of the foreground, those on the opposite bank, the wall, and the broad shadows on the trees, principally representing all the deeper tones which were produced in the sepia drawing and marked *c c* in Fig. 6. Prepare a tint of gamboge, yellow ochre, and a little indigo, and pass over the lights on the grass, on the sides of the banks on both sides of the river, and the lights on the trees at *s s*; this may be horizontally and sparingly repeated on the surface of the water where there is a reflection of the bank on the water. The worn path at *g*, made out with the grey tint, must be left and painted with broken touches, where it is bare of grass, with the same colour as the road—that is, with a mixture of yellow ochre and a little Indian red; a broken tint of light grey (the same that was used for the clouds) dragged over the darker parts of the road at *h h*, will cool it; at the same time this grey may be employed to particularise parts and details in the foreground (posts, etc.), also the darker parts of the water at *k k*. A very light wash of terre-verte and lake may be passed over some of the shadows or reflections on the water: this transparent grey, if not overdone, will be found exceedingly useful in toning down many parts not having any direct light cast upon them. The lights of the tall dark tree may be made with brown pink and a little indigo; this colour regulated with indigo may be employed in making out the shadows of all the trees, carefully preserving the lights; as there are different degrees of shadows, so different tones of this colour may be used in some of the depths with the addition of a little lake. The sandy bank at *m* to be covered with yellow ochre broken here and there with a little Indian red, and the shadows made out with the grey of the clouds; the distance *n*, cobalt and lake with a little terre-verte to neutralise the purple produced by the lake with the blue. Afterwards the herbage in the foreground may be slightly glazed with burnt sienna; any of the other parts of the picture already painted may be glazed with some warm colours if the greys are too powerful, though care must be taken not to make them dirty.

FOREGROUND, MIDDLE, AND EXTREME DISTANCE.

Our remarks for a time will be in a great measure directed to tones, and their gradations, as they recede from the foreground to the remotest part of the picture. The subject has been introduced before, but only in reference to other matters, merely stating that colours as well as forms become more generalised and melted together as they recede: in other words, colours as they retire are more subdued by and intermingled with grey tones, and the details of forms are lost in the united combination of masses. But yet there must be one and the same principle carried throughout; whilst objects in the foreground should be crisply rendered and well defined, there must still be one harmonious union of the whole; no one part must appear prominently at the expense of another, and the masses of light and shade must be so managed that the recognised features of the landscape may present themselves with sufficient force and identity to give individuality to the scene. We may make the same observations respecting the middle distance, but with this exception, that particulars should be less defined, and still less as the subject recedes in the distance. If these characteristic distinctions are observed throughout, with a due regard to the requisite amount of labour each respectively demands, we shall in the end attain our object in giving expression to form, and of combining harmony of colour with unity of tone.

First, with regard to foregrounds. As the drawing, or description of particulars, is so very essential towards making a successful picture, we advise our pupils to attempt the present illustration (Fig. 8) first in sepia, solely with a view of improving their power of giving expression to all the various details throughout. Those who have earnestly taken up the subject of painting, and have accompanied us from the commencement of

these lessons, will have found out by this time how much depends upon a conscientious and scrupulous observance of drawing details faithfully; for mere washing in colour, without any regard to the form of the object which it is intended to assist in by close observation and study; it is one that gains additional strength from every effort, and he who possesses it will become more and more convinced of the fact, that without a strict attention to all characteristic details, whether they

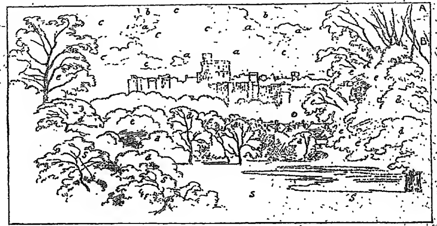


Fig. 8.

representing, is but daubing. At the same time, we decidedly object to microscopic manipulation; in other words, whilst there must be a truthful embodiment of all that is indispensable for the preservation of character, regard must be paid to the masses as they stand related to each other, some more prominent and defined as they approach the light, others subdued and generalised as they recede into half-tint and shadow. It will not be difficult, then, to understand why we lay so much stress upon drawing, and the power of drawing to enable us to accomplish all that we desire: not, perhaps, that we are able to see all at first, as this is an increasing faculty, perfecting itself by experience; but a mind habitually directed towards the attainment of this power of discriminating the most delicate tones and the most minute characteristic differences of form, however insignificant each may seem to be when taken by itself, will quickly discover them, and fully understand that it is the combination of all these as a whole that makes the difference we acknowledge to exist between one object and another of the same class. This enviable power, then, is to be acquired refer only to parts of objects, with respect to their individual forms, or the same under some special influence of light, or subjugation by shade, no satisfactory result can possibly reward his efforts.

After the whole of the drawing has been very carefully made out, commence by putting in the dark broad shadows on the trees, and paint them in such a way that the high lights and middle tone may be left. When this part of the work is dry, tone down some of the more subdued parts with a middle tint, preserving those branches which are to receive the greatest proportion of light; this will enable the pupil to understand the tone necessary for the sky afterwards, which must be painted with a flat light tint, leaving the clouds to be broken off at those edges which are *away from the light*; when this is dry a somewhat darker tint must be used for the cloud shadows, and their edges *towards the light* broken off as before. By *breaking off the edges* we do not mean entirely washing them off, but only partially so, as some portions of the edges must be left sharp and distinct, whilst others as they round off into shade

may be softened a little, in proportion to the force of light cast upon the parts respectively. We shall have but few additional remarks to make upon the process of printing this subject in sepia, as the substance of much that has been already given in to be left, and the blue passed over the portions marked *b*; the edges of the blue over which the shadows of the clouds are to be made out must be softened down, and the rest must be treated as we have explained in the sepia drawing. Add a

Fig. 9. (Windsor Castle.)

previous lessons applies equally to this case; generally speaking, let the trees be somewhat advanced—that is, to use an artistic phrase, "blocked in," then the principal masses of light and shade may be attended to in the middle distance. This distribution of labour will assist the judgment of the pupil to determine the strength of tone to be applied to the several parts, according to their positions in the landscape.

We will now open the colour-box:—Commence with the blue (cobalt) of the sky at A (Fig. 8) and pass it over the paper where the trees are to be painted to about B. As a rule, we may generally go over a dark tint with a light one, or, which amounts to the same, where a dark tint is afterwards to be painted; therefore, as the trees are darker than the sky, and besides, as there is blue in the green, no particular damage can be done to the trees with the blue of the sky; but should portions of the trees upon the sky be prominently exposed to the light, making the branches of a warmer or lighter tone, the blue of the sky may be spared, as this colour neutralises or subdues every light or warm colour over which it passes. The lights of the clouds are all marked *a*—these are little sepia and very little lake to the cobalt that remains in the saucer for the shadows of the clouds marked *c*. As these shadows approach the light they must be broken; on the sides away from the light they may be a little more decisive—that is, they must be very little softened. Whilst the sky is drying, cover the high lights of the trees at *d* with a light tint of yellow ochre. (Our pupils must recollect a former caution of not using too powerful tints, as they may be increased afterwards, when dry, if necessary.) The foreground may receive the same colour in those parts where the light is strongest. If we were painting from Nature, we might probably see some warmer tints, on branches, or where fallen leaves may lie in the foreground. In this case, a little burnt sienna might be added. After this, the foreground and trees may be carried on for the sake of other parts of the picture, as we explained in the sepia painting. When the lights of the trees are dry, mix a little brown pink with indigo and lake in the proportion of 2, 2, and 1, for the shadows and depths of the trees (this tint we will call No. 1); also have in another saucer the same tint with the addition of more indigo (this cooler tint we will call No. 2);

then with two brushes, one for each tint, proceed as follows:—Paint in with No. 2 the lower depths of the trees that are more remote from the light, as at *e*. and with No. 1 paint in the outer branches nearer the light; these two tints being laid side by side whilst wet, as described, will harmonise well, and produce an atmospheric effect amongst the branches. The bright lights on the ground, and on the most prominent branches, may receive a little gamboge at *s*. At the lower parts of the middle distance, where the town is seen above the trees at *o*, the same atmospheric effect may be preserved with a tint of cobalt and a little lake. The shadows and darker parts of the houses may be made out with this last tint, when the foreground and trees are somewhat advanced, but not finished; the dark parts and details of the castle may be made out with the grey of the clouds, the light sides with a little yellow ochre, and we might add, but it must be done judiciously, a very small portion of raw umber; too much of this latter colour would probably dirty the tints, but when moderately used, the yellow ochre will be a little subdued. Paint the red bricks of the houses with a tint of Indian red, observing the gradations of tone, some stronger than others. This colour works well with the cobalt and lake of the shadows. The hills and the distance must be carefully picked out with cobalt and lake. Amongst the shadows of this part of the picture, a grey composed of terre-verte and a very little lake will be useful; even yellow ochre, sparingly employed as a glazing colour over some of the brighter lights, will give value by contrast with the pearly greys and blue tones. Return to the trees and foreground, and break over the masses with brown pink and terre-verte, dipping the brush into a little gamboge for the brighter parts: this will flatten them a little, but they can afterwards be relieved and the details assisted with touches of brown pink and indigo; all the previous greyer tones painted with the indigo tint will still keep their places, if the terre-verte and brown-pink tint is not too freely spread over them.

The above instructions may be observed for the general treatment of the subject, but our pupils must bear in mind that there are many minor and additional particulars which relate to accidental effects that could scarcely be introduced here. As we have before remarked, close and continual observation on their part will make them acquainted with many facts relating to colours and tints. A great deal of what we have written can hardly be considered as more than a foundation for an art which must eventually be perfected by unwearied application and perseverance.

ALGEBRA.—XI.

[Continued from p. 215.]

EVOLUTION.

213. The process of *resolving* quantities into *equal factors* is called *evolution*.

In *subtraction*, a quantity is resolved into *two parts*.

In *division*, a quantity is resolved into *two factors*.

In *evolution*, a quantity is resolved into *equal factors*.

Evolution is the opposite of *involution*. The latter is finding a *power* of a quantity, by multiplying it into itself. The former is finding a *root*, by resolving a quantity into *equal* factors. A quantity is resolved into any number of equal factors by dividing its *index* into as many *equal parts*.

214. From the foregoing principles we deduce the following

GENERAL RULE FOR EVOLUTION.

Divide the index of the quantity by the number expressing the root to be found. Or,

Place the radical sign belonging to the required root over the given quantity.

If the quantities have coefficients, *the root of these must be extracted and placed before the radical sign or quantity.* Thus,

To find the square root of d^4, divide the index 4 by 2; *i.e.*, $d^{\frac{4}{2}} = d^2$. So the cube root of d^6 is $d^{\frac{6}{3}} = d^2$.

Obs.—From the manner of performing *evolution* it is evident that the plan of denoting roots by *fractional* indices is derived from the mode of expressing powers by *integral* indices.

EXAMPLES.

Required the cube root of a^6. *Ans.* $\sqrt[3]{a^6} = a^{\frac{6}{3}} = a^2$.

Required the cube root of a or a^1. *Ans.* $a^{\frac{1}{3}}$, or $\sqrt[3]{a}$.

For $a^{\frac{1}{3}} \times a^{\frac{1}{3}} \times a^{\frac{1}{3}}$, or $\sqrt[3]{a} \times \sqrt[3]{a} \times \sqrt[3]{a} = a$.

215. The rule in the preceding article may be applied to every case in *evolution*. But when the quantity whose root is to be found is composed of *several factors*, there will frequently be an advantage in taking the root of each of the factors *separately*.

This is done upon the principle that the *root of the product of several factors is equal to the product of their roots.*

Thus $\sqrt{ab} = \sqrt{a} \times \sqrt{b}$; for each member of the equation, if raised to any power, will give the same result.

When, therefore, a quantity consists of several factors, we may either extract the root of the whole together, or we may find the root of the factors separately, and then multiply them into each other.

EXAMPLE.—The cube root of xy is either $(xy)^{\frac{1}{3}}$, or $x^{\frac{1}{3}}y^{\frac{1}{3}}$.

The root of a fraction is equal to the root of the numerator divided by the root of the denominator.

EXAMPLE.

Thus the square root of $\frac{a}{b} = \frac{a^{\frac{1}{2}}}{b^{\frac{1}{2}}}$. For $\frac{a^{\frac{1}{2}}}{b^{\frac{1}{2}}} \times \frac{a^{\frac{1}{2}}}{b^{\frac{1}{2}}} = \frac{a}{b}$.

216. SIGNS.—(1) *An odd root of any quantity has the same sign as the quantity itself.*

(2) *An even root of a positive quantity is ambiguous.*

(3) *An even root of a negative quantity is impossible.*

But an *even* root of a *positive* quantity may be either *positive* or *negative*. For the quantity may be produced from the one, as well as from the other.

Thus the square root of a^2 is $+ a$, or $- a$.

An even root of a positive quantity is therefore said to be *ambiguous*, and is marked with the sign $\pm$. Thus the square root of $3b$ is $\pm \sqrt{3b}$. The 4th root of x is $\pm x^{\frac{1}{4}}$.

The ambiguity does not exist, however, when, from the nature of the case, or a previous multiplication, it is known whether the power has actually been produced from a *positive* or from a *negative* quantity.

But no *even* root of a *negative* quantity can be found.

The square root of $-a^2$ is neither $+a$ nor $-a$.

For $+a \times +a = +a^2$; and $-a \times -a = +a^2$ also.

An *even* root of a *negative* quantity is therefore said to be *impossible* or *imaginary*.

217. The methods of extracting the roots of *compound* quantities need not be considered here. But there is one class of them, the squares of *binomial* and *residual* quantities, which it will be proper to attend to in this place. The square of $a + b$, for instance, is $a^2 + 2ab + b^2$, two terms of which, a^2 and b^2, are complete powers, and $2ab$ is twice the product of a into b, that is, the root of a^2 into the root of b^2.

Whenever, therefore, we meet with a quantity of this description, we may know that its square root is a binomial; and this may be found by taking the root of the two terms which are complete powers, and connecting them by the sign $+$. The other term disappears in the root. Thus, to find the square root of $x^2 + 2xy + y^2$, take the root of x^2, and the root of y^2, and connect them by the sign $+$. The binomial root will then be $x + y$.

In a *residual* quantity, the double product has the sign $-$ prefixed, instead of $+$. The square of $a - b$, for instance, is $a^2 - 2ab + b^2$. And to obtain the root of a quantity of this description, we have only to take the roots of the two complete powers, and connect them by the sign $-$. Thus the square root of $x^2 - 2xy + y^2$ is $x - y$. Hence, to extract the square root of a *binomial* or *residual*,

Take the roots of the two terms which are complete powers, and connect them by the sign which is prefixed to the other term.

EXAMPLE.—To find the square root of x^2+2x+1.

The two terms which are complete powers are x^2 and 1. The roots are x and 1. Then $x + 1 =$ required root.

EXERCISE 47.

1. Required the 5th root of ab.
2. Required the nth root of a^2.
3. Required the 7th root of $2d - x$.
4. Required the 5th root of $(a - x)^3$.
5. Required the cube root of $a^{\frac{1}{2}}$.
6. Required the 4th root of a^{-1}.
7. Required the cube root of $a^{\frac{3}{5}}$.
8. Required the nth root of x^m.
9. Required the 3rd root of y^3.
10. Required the 4th root of x^8.
11. Required the 2nd root of x^n.
12. Required the 5th root of d^3.
13. Required the 6th root of a^3.
14. Required the 5th root of $3y$.
15. Required the 6th root of abh.
16. Required the cube root of $8b$.
17. Required the nth root of x^ny.
18. Required the nth root of $\frac{a}{b}$, and the cube root of $\frac{c}{d^3}$.
19. Required the square root of $\frac{x}{ay}$, and the 5th root of $\frac{b^3}{c^4}$.
20. Required the square root of $x^2 - 2x + 1$.
21. Required the square root of $a^2 + a + \frac{1}{4}$.
22. Required the square root of $a^2 + \frac{2}{3}a + \frac{1}{9}$.
23. Required the square root of $a^2 + ab + \frac{b^2}{4}$.
24. Required the square root of $a^2 + \frac{2ab}{c} + \frac{b^2}{c^2}$.

SURDS AND RADICAL QUANTITIES.

218. *A root whose value cannot be exactly expressed in numbers is called a* SURD, *or irrational quantity.*

Thus, $\sqrt{2}$ is a surd, because the square root of 2 cannot be expressed in numbers with perfect exactness.

In decimals, it is 1·41421356 nearly.

Every quantity which is not a *surd* is said to be *rational.*

By RADICAL QUANTITIES is meant all quantities which are found under the *radical sign*, or *which have a fractional index.*

REDUCTION OF RADICAL QUANTITIES.

219. CASE I.—To reduce a *rational* quantity to the form of a *radical* without altering its value.

Raise the quantity to a power of the same name as

the given root, and then apply the corresponding radical sign or index.

EXAMPLE.—Reduce a to the form of the nth root.

The nth power of a is a^n. Over this place the radical sign, and it becomes $\sqrt[n]{a^n}$.

It is thus reduced to the form of a radical quantity without any alteration of its value. For $\sqrt[n]{a^n} = a^{\frac{n}{n}} = a$.

N.B.—In cases of this kind, where a *power* is to be reduced to the form of the nth root, it must be raised to the nth power, not of the *given letter*, but of the *power* of the letter.

Thus, in the fifth example, Exercise 48, a^6 is the cube, not of a, but of a^2.

220. CASE II.—To reduce quantities which have *different indices* to others of the same value having *a common index.*

(1) *Reduce the indices to a common denominator.*

(2) *Raise each quantity to the power expressed by the numerator of its reduced index.*

(8) *Take the root denoted by the common denominator.*

EXAMPLES.

Reduce $a^{\frac14}$ and $b^{\frac16}$ to a common index.

1st. The indices $\frac14$ and $\frac16$ reduced to a common denominator are $\frac{3}{12}$ and $\frac{2}{12}$.

2nd. The quantities a and b raised to the powers expressed by the two numerators are a^3 and b^2.

3rd. The root denoted by the common denominator is the $\frac{1}{12}$th. The answer, then, is $(a^3)^{\frac{1}{12}}$ and $(b^2)^{\frac{1}{12}}$.

The two quantities are thus reduced to a common index, without any alteration of their values.

For $a^{\frac14} = a^{\frac{3}{12}}$, which $= (a^3)^{\frac{1}{12}}$.

And universally, $a^{\frac{1}{n}} = a^{\frac{m}{mn}} = (a^m)^{\frac{1}{mn}}$.

Reduce $a^{\frac12}$ and $(bx)^{\frac23}$ to a common index.

Here $a^{\frac12}$ and $(bx)^{\frac23} = a^{\frac36}$ and $(bx)^{\frac46}$, or $(a^3)^{\frac16}$ and $(b^4x^4)^{\frac16}$.

221. CASE III.—To reduce a quantity to one with *a given index.*

Divide the index of the quantity by the given index, place the quotient over the quantity, and set the given index over the whole.

This is merely resolving the original index into two factors.

EXAMPLES.

Reduce $a^{\frac16}$ to one with the index $\frac12$.

$$\tfrac16 \div \tfrac12 = \tfrac16 \times \tfrac21 = \tfrac26 = \tfrac13.$$

This is the index to be placed over a, which then becomes $a^{\frac13}$; and the given index set over this, makes it $(a^{\frac13})^{\frac12}$, the answer.

Reduce a^2 and $x^{\frac32}$ to others with the common index $\frac13$.

$2 \div \frac13 = 2 \times 3 = 6$, the first index.

$\frac32 \div \frac13 = \frac32 \times 3 = \frac92$, the second index.

Therefore $(a^6)^{\frac13}$ and $(x^{\frac92})^{\frac13}$ are the quantities required.

EXERCISE 48.

1. Reduce 4 to the form of the cube root.
2. Reduce $8a$ to the form of the 4th root.
3. Reduce $\frac12 ab$ to the form of the square root.
4. Reduce $8 \times (a - x)$ to the form of the cube root.
5. Reduce a^6 to the form of the cube root.
6. Reduce a^2b^4 to the form of the square root.
7. Reduce a^m to the form of the nth root.
8. Reduce a^2 and $b^{\frac{2}{n}}$ to a common index.
9. Reduce $x^{\frac{1}{n}}$ and $y^{\frac{1}{m}}$.
10. Reduce $2^{\frac12}$ and $3^{\frac13}$.
11. Reduce $(a+b)^2$ and $(x-y)^{\frac12}$.
12. Reduce $a^{\frac12}$ and $b^{\frac14}$.
13. Reduce $x^{\frac34}$ and $5^{\frac23}$.
14. Reduce $4^{\frac12}$ and $3^{\frac14}$ to others with the common index $\frac13$
15. Reduce x^2 and y^4 to others with the common index $\frac12$.
16. Reduce $a^{\frac13}$ and $b^{\frac12}$ to others with the common index $\frac16$.
17. Reduce c^2 and $d^{\frac12}$ to others with the common index $\frac14$.
18. Reduce $a^{\frac{1}{n}}$ and $b^{\frac{2}{m}}$ to others with the common index $\frac{1}{n}$.
19. Reduce $a^{\frac12}$, $b^{\frac13}$, and $c^{\frac14}$ to others with the common index $\frac{1}{12}$.

222. CASE IV.—To reduce a radical quantity to its *most simple terms*; *i.e.*, to remove a factor from under the radical sign.

Resolve the quantity into two factors, one of which is an exact power of the same name with the root. Find the root of this power, and prefix it to the other factor, with the radical sign between them.

This rule is founded on the principle that the root of the *product* of two factors is equal to the *product* of their roots.

It will generally be best to resolve the radical quantity into such factors, that one of them shall be the *greatest* power which will divide the quantity without a remainder.

N.B.—If there is no *exact* power which will divide the quantity, the deduction cannot be made.

EXAMPLES.

Remove a factor from $\sqrt{8}$.

The greatest square which will divide 8 is 4. We may then resolve 8 into the factors 4 and 2; for $4 \times 2 = 8$.

The root of this product is equal to the product of the roots of its factors; that is, $\sqrt{8} = \sqrt{4} \times \sqrt{2}$.

But $\sqrt{4} = 2$. Instead of $\sqrt{4}$, therefore, we may substitute its equal 2. We then have $2 \times \sqrt{2}$, or $2\sqrt{2}$, for the answer.

Reduce $\sqrt{a^2x}$. *Ans.* $\sqrt{a^2} \times \sqrt{x} = a \times \sqrt{x} = a\sqrt{x}$.

223. CASE V.—To introduce a *coefficient* of a radical quantity under the radical sign.

Rule: the coefficient to a power of the same name as the radical part, then place it as a factor under the radical sign.

EXAMPLES.

Thus, $a\sqrt[n]{b} = \sqrt[n]{a^n b}$. For $a = \sqrt[n]{a^n}$, or $a^{\frac{n}{n}}$; and $\sqrt[n]{a^n} \times \sqrt[n]{b} = \sqrt[n]{a^n b}$.

Reduce $a(x-b)^{\frac{1}{2}}$ to the form of a radical.

$$a(x-b)^{\frac{1}{2}} = \sqrt[2]{a^2(x-b)} = (a^2x - a^2b)^{\frac{1}{2}}.$$

EXERCISE 49.

1. Reduce $\sqrt{18}$ to its simplest form.
2. Reduce $\sqrt[3]{64b^3c}$.
3. Reduce $\sqrt{\frac{a^2b}{c^2d}}$.
4. Reduce $\sqrt[n]{a^nb}$.
5. Reduce $(a^3 - a^2b)^{\frac{1}{2}}$.
6. Reduce $(54a^3b)^{\frac{1}{3}}$.
7. Reduce $\sqrt{98x^2y}$.
8. Reduce $\sqrt[3]{a^4 + a^3b^2}$.
9. Reduce $2ab(2a^2b^2)^{\frac{1}{2}}$.
10. Reduce $\frac{a}{b}\left(\frac{b^2c}{a^2 + b^2}\right)^{\frac{1}{2}}$
11. Reduce $2\sqrt{2}$.
12. Reduce $4b^2\sqrt{c}$.
13. Reduce $3\sqrt{a}$ to a simple radical form.
14. Reduce $\frac{1}{3}\sqrt{54}$ to a simple radical form.
15. Reduce $5^{\frac{1}{2}}$ and $6^{\frac{1}{3}}$ to others with the common index $\frac{1}{6}$.
16. Reduce $a^{\frac{1}{2}}$ and $a^{\frac{2}{3}}$ to others with the common index $\frac{1}{6}$.
17. Reduce $\sqrt{98}$ to its simplest form.
18. Reduce $\sqrt{243}$ to its simplest form.
19. Reduce $\sqrt[3]{54}$ to its simplest form.
20. Reduce $7\sqrt{80}$ to its simplest form.
21. Reduce $9\sqrt[3]{81}$ to its simplest form.
22. Reduce $\sqrt{x^4 + ax^2}$ to its simplest form.
23. Reduce $\sqrt{1053x}$ to its simplest form.
24. Reduce $\sqrt{x^5 - a^2x^3}$ to its simplest form.

ADDITION OF RADICAL QUANTITIES.

224. It may be proper to remark that the rules for addition, subtraction, multiplication, and division of *radical quantities* depend on the *same principles*, and are expressed in nearly the same language, as those for addition, subtraction, multiplication, and division of *powers*. So also the rules for involution and evolution of radicals are *similar* to those for involution and evolution of powers. Hence, if the learner has made himself thoroughly acquainted with the principles and operations relating to powers, he has substantially acquired those pertaining to radical quantities, and will find no difficulty in understanding and applying them.

When radical quantities have the *same radical part*, and are under the *same radical sign* or *index*, they are *like* quantities. Hence their *rational parts* or *coefficients* may be added in the same manner as *rational* quantities, and the sum prefixed to the *radical* part.

Thus, $2\sqrt{b} + 3\sqrt{b} = 5\sqrt{b}$.

If the radical parts are originally different, they may sometimes be made alike by the rules for reduction of radical quantities.

EXAMPLE.—Add $\sqrt{8}$ to $\sqrt{50}$.

Here the radical parts are not the same; but by reduction, $\sqrt{8} = 2\sqrt{2}$, and $\sqrt{50} = 5\sqrt{2}$; and $2\sqrt{2} + 5\sqrt{2} = 7\sqrt{2}$. *Ans.*

EXERCISE 50.

1. Add $\sqrt[n]{ay}$ to $2\sqrt[n]{ay}$.
2. Add $-2\sqrt{a}$ to $5\sqrt{a}$.
3. Add $4(x+h)^{\frac{1}{2}}$ to $3(x+h)^{\frac{1}{2}}$.
4. Add $7bh^{\frac{1}{2}}$ to $5bh^{\frac{1}{2}}$.
5. Add $y\sqrt{b-h}$ to $a\sqrt{b-h}$.
6. Add $\sqrt{16b}$ to $\sqrt{4b}$.
7. Add $\sqrt{a^2x}$ to $\sqrt{b^2x}$.
8. Add $(36a^2y)^{\frac{1}{2}}$ to $(25y)^{\frac{1}{2}}$.
9. Add $\sqrt{18a}$ to $3\sqrt{2a}$.

225. If the radical parts, after reduction, are *different*, or have *different exponents*, then the quantities, being *unlike*, can be added only by writing them one after the other with their signs.

EXAMPLES.

The sum of $3\sqrt{b}$ and $2\sqrt{a}$, is $3\sqrt{b} + 2\sqrt{a}$.

It is manifest that three times the root of b, and twice the root of a, are neither five times the root of b, nor five times the root of a, unless b and a are equal.

The sum of $\sqrt[2]{a}$ and $\sqrt[3]{a}$, is $\sqrt[2]{a} + \sqrt[3]{a}$.

The *square* root of a, and the *cube* root of a, are neither twice the square root, nor twice the cube root of a.

226. From the preceding principles we deduce the following—

GENERAL RULES FOR ADDITION OF RADICALS.

If the radical parts are the same, add their coefficients, and to the sum annex the common radical parts.

If the radicals are unlike quantities, they must be added by writing them one after another, without altering their signs.

EXAMPLE.—Add $\sqrt{28}$ to $\sqrt{63}$.

$$\sqrt{28} = \sqrt{(4 \times 7)} = 2\sqrt{7}.$$
$$\sqrt{63} = \sqrt{(9 \times 7)} = 3\sqrt{7},$$
$$\text{Sum} = \overline{5\sqrt{7}}$$

EXERCISE 51.

1. Add $\sqrt{27}$ to $\sqrt{48}$.
2. Add $\sqrt{72}$ to $\sqrt{128}$.
3. Add $\sqrt{180}$ to $\sqrt{405}$.
4. Add $3\sqrt[3]{40}$ to $\sqrt[3]{135}$.
5. Add $4\sqrt[3]{54}$ to $5\sqrt[3]{128}$.
6. Add $9\sqrt{243}$ to $10\sqrt{363}$.
7. Add $\sqrt{81b}$ to $\sqrt{49b}$.
8. Add $\sqrt{9a^2d}$ to $\sqrt{16a^2d}$.
9. Add $x\sqrt{25x^2c}$ to $\sqrt{36x^4c}$.
10. Add $3\sqrt[3]{a^4b}$ to $4a\sqrt[3]{ab}$.

SUBTRACTION OF RADICAL QUANTITIES.

227. RULE.—*Subtraction of radicals is performed in the same manner as addition, except that the signs of the subtrahend must be changed as in subtraction of other quantities.*

EXAMPLE.—From $\sqrt[3]{81x}$ take $\sqrt[3]{24x}$.

$$\sqrt[3]{81x} = \sqrt[3]{(27 \times 3x)} = 3\sqrt[3]{3x}.$$
$$\sqrt[3]{24x} = \sqrt[3]{(8 \times 3x)} = 2\sqrt[3]{3x}.$$
$$\text{Difference} = \sqrt[3]{3x}.$$

EXERCISE 52.

1. From $\sqrt{ay}$ take $3\sqrt{ay}$.
2. From $4^n\sqrt{a+x}$ take $3^n\sqrt{a+x}$.
3. From $3h^{\frac{1}{2}}$ take $-5h^{\frac{1}{2}}$.
4. From $a(x+y)^{\frac{1}{2}}$ take $b(x+y)^{\frac{1}{2}}$.
5. From $-a^{\frac{1}{n}}$ take $-3a^{\frac{1}{n}}$.
6. From $\sqrt{50}$ take $\sqrt{8}$.
7. From $\sqrt[3]{b^4y}$ take $\sqrt[3]{by^4}$.
8. From $\sqrt[n]{x}$ take $\sqrt[n]{x}$.
9. From $2\sqrt{50}$ take $\sqrt{18}$.
10. From $\sqrt[3]{320}$ take $\sqrt[3]{40}$.
11. From $5\sqrt{20}$ take $3\sqrt{45}$.
12. From $\sqrt{80a^4x}$ take $\sqrt{20a^2x}$.

MULTIPLICATION OF RADICAL QUANTITIES.

228. Radical quantities may be multiplied, like other quantities, by writing the factors one after another, either with or without the sign of multiplication between them.

EXAMPLES.

Thus the product of $\sqrt{a}$ into $\sqrt{b}$, is $\sqrt{a} \times \sqrt{b}$.

The product of $h^{\frac{1}{2}}$ into $y^{\frac{1}{3}}$, is $h^{\frac{1}{2}}y^{\frac{1}{3}}$.

229. But it is often expedient to bring the factors under the same radical sign. This may be done, if they are first reduced to a common index.

*Hence, quantities under the same radical sign or index may be multiplied together like rational quantities, the product being placed under the common radical sign or index.**

EXAMPLE.—Multiply $\sqrt[2]{x}$ into $\sqrt[3]{y}$, that is, $x^{\frac{1}{2}}$ into $y^{\frac{1}{3}}$.

The quantities reduced to the same index, are $(x^3)^{\frac{1}{6}}$, and $(y^2)^{\frac{1}{6}}$, and their product is $(x^3y^2)^{\frac{1}{6}} = \sqrt[6]{x^3y^2}$. *Ans.*

In this manner the product of radical quantities often becomes *rational*.

EXAMPLE.—Thus the product of $\sqrt{2}$ into $\sqrt{18} = \sqrt{36} = 6$. *Ans.*

230. *Roots of the same letter or quantity may be multiplied by adding their fractional exponents.*

N.B.—The *exponents*, like all other fractions, must be reduced to a common denominator before they can be united in one term.

EXAMPLE.—Thus $a^{\frac{1}{2}} \times a^{\frac{1}{3}} = a^{\frac{1}{2}+\frac{1}{3}} = a^{\frac{3}{6}+\frac{2}{6}} = a^{\frac{5}{6}}$.

231. The values of the roots are not altered by reducing their indices to a common denominator.

Therefore the first factor $a^{\frac{1}{2}} = a^{\frac{3}{6}}$
And the second $a^{\frac{1}{3}} = a^{\frac{2}{6}}$

But $a^{\frac{3}{6}} = a^{\frac{1}{6}} \times a^{\frac{1}{6}} \times a^{\frac{1}{6}}$; and $a^{\frac{2}{6}} = a^{\frac{1}{6}} \times a^{\frac{1}{6}}$.

The product therefore is $a^{\frac{1}{6}} \times a^{\frac{1}{6}} \times a^{\frac{1}{6}} \times a^{\frac{1}{6}} \times a^{\frac{1}{6}} = a^{\frac{5}{6}}$.

N.B.—In all instances of this nature, the common denominator of the indices denotes a certain root; and the sum of the numerators shows how often this is to be repeated as a factor to produce the required product.

EXAMPLE.—Thus $a^{\frac{1}{n}} \times a^{\frac{1}{m}} = a^{\frac{m}{mn}} \times a^{\frac{n}{mn}} = a^{\frac{m+n}{mn}}$.

232. Any quantities may be reduced to the form of radicals, and may then be subjected to the same modes of operation.

Thus $y^3 \times y^{\frac{1}{2}} = y^{3+\frac{1}{2}} = y^{\frac{7}{2}}$; and $a \times a^{\frac{1}{n}} = a^{\frac{n+1}{n}}$.

N.B.—The product will become *rational* whenever the *numerator* of the index can be exactly divided by the *denominator*.

EXAMPLE.—Thus $a^{3} \times a^{\frac{1}{2}} \times a^{\frac{1}{2}} = a^{\frac{8}{2}} = a^{4}$.

233. When radical quantities which are reduced to the same index have rational coefficients, the rational parts may be multiplied together, and their product prefixed to the product of the radical parts.

EXAMPLE.—Multiply $a\sqrt{b}$ into $c\sqrt{d}$.

The product of the rational parts is ac.
The product of the radical parts is $\sqrt{bd}$.
And the whole product $= ac\sqrt{bd}$. *Ans.*

But in cases of this nature we may save the trouble of reducing to a common index, by multiplying.

EXAMPLE.—Thus $ax^{\frac{1}{2}}$ into $bd^{\frac{1}{3}} = ax^{\frac{1}{2}}bd^{\frac{1}{3}}$. *Ans.*

EXERCISE 53.

1. Multiply $\sqrt{a+m}$ into $\sqrt{a-m}$.
2. Multiply $\sqrt{dx}$ into $\sqrt{hy}$.
3. Multiply $a^{\frac{1}{2}}$ into $x^{\frac{1}{2}}$.
4. Multiply $(a+y)^{\frac{1}{n}}$ into $(b+h)^{\frac{1}{n}}$.
5. Multiply $a^{\frac{1}{m}}$ into $x^{\frac{1}{m}}$.
6. Multiply $\sqrt{3xb}$ into $\sqrt{2xb}$.
7. Multiply $(a^2y^2)^{\frac{1}{3}}$ into $(a^2y)^{\frac{1}{3}}$.
8. Multiply $3y^{\frac{1}{2}}$ into $y^{\frac{3}{2}}$.
9. Multiply $(a+b)^{\frac{1}{2}}$ into $(a+b)^{\frac{1}{2}}$.
10. Multiply $(a-y)^{\frac{1}{m}}$ into $(a-y)^{\frac{1}{m}}$.
11. Multiply $x^{\frac{1}{2}}$ into $x^{\frac{1}{3}}$.
12. Multiply $y^{\frac{1}{2}}$ into $y^{\frac{1}{3}}$.
13. Multiply $x^{\frac{m}{n}}$ into $x^{\frac{r}{s}}$.
14. Multiply $x^{-\frac{2}{3}}$ into $x^{-\frac{1}{3}}$.
15. Multiply a^{2} into $a^{\frac{1}{2}}$.
16. Multiply $(a+b)^{\frac{2}{3}}$ into $(a+b)^{\frac{1}{3}}$.
17. Multiply $a^{\frac{2}{3}}$ into $a^{\frac{4}{3}}$.
18. Multiply $ax^{\frac{1}{2}}$ into $bd^{\frac{1}{3}}$.
19. Multiply $a(b+x)^{\frac{1}{2}}$ into $y(b-x)^{\frac{1}{2}}$.
20. Multiply $a\sqrt{y^2}$ into $b\sqrt{hy}$.
21. Multiply $a\sqrt{x}$ into $b\sqrt{x}$.
22. Multiply $ax^{-\frac{1}{2}}$ into $by^{-\frac{1}{2}}$.
23. Multiply $x^{\frac{1}{2}}\sqrt{3}$ into $y^{\frac{1}{2}}\sqrt{9}$.
24. Multiply $\sqrt[3]{ab}$ into $\sqrt[3]{ab}$.

234. If the rational quantities, instead of being *coefficients* to the radical quantities, are connected with them by the signs $+$ and $-$, each term in the multiplier must be multiplied into each term of the multiplicand.

EXAMPLE.—

$$\begin{array}{rl}
\text{Multiply} & a + \sqrt{b} \\
\text{Into} & c + \sqrt{d} \\
\hline
& ac + c\sqrt{b} \\
& \qquad a\sqrt{d} + \sqrt{bd} \\
\hline
& ac + c\sqrt{b} + a\sqrt{d} + \sqrt{bd}. \quad \textit{Ans.}
\end{array}$$

235. Hence we deduce the following

* The case of an *imaginary* root of a negative quantity may be considered an exception.

GENERAL RULE FOR MULTIPLYING RADICALS.

Radicals of the same root are multiplied by adding their fractional exponents.

If the quantities have the same radical sign or index, multiply them together as you multiply rational quantities, place the product under the common radical sign, and to this prefix the product of their coefficients.

If the radicals are compound quantities, each term in the multiplier must be multiplied into each term of the multiplicand by writing the terms one after another, either with or without the sign of multiplication between them.

EXERCISE 64.

1. Multiply $18^3\sqrt{a^2}$ into $10^3\sqrt{a}$.
2. Multiply $4^n\sqrt{xy}$ into $\frac{1}{2}^n\sqrt{x^{n-2}}$.
3. Multiply $a\sqrt{x}$ into $m^3\sqrt{y}$.
4. Multiply $\frac{2}{3}^3\sqrt{\frac{a}{4}}$ into $\frac{1}{2}^3\sqrt{\frac{a}{2}}$.
5. Multiply $5x^{\frac{1}{2}}$ into $4x^{\frac{1}{4}}$.
6. Multiply $3^6\sqrt{4x}$ into $2^3\sqrt{14x^{-1}}$.
7. Multiply $\sqrt{-y}$ into $\sqrt{-y}$.
8. Multiply $1-\sqrt{2}$ into $2+\frac{1}{\sqrt{2}}$.
9. Multiply $(a-x+\sqrt{-ax})$ into $(a-x-\sqrt{ax})$.
10. Multiply $22(a+c)^{\frac{1}{2}}$ into $5(a+c)^{\frac{1}{2}}$.
11. Multiply $^5\sqrt{^3\sqrt{a^2}}$ into $^6\sqrt{^4\sqrt{a^3}}$.
12. Multiply $a^{-\frac{2}{3}}b^{-2}$ into $a^{\frac{2}{3}}b^{\frac{1}{2}}c$.

KEY TO EXERCISES.

EXERCISE 41.

1. $\frac{1}{2}(a+b)$, and $\frac{1}{2}(a-b)$.
2. 12 the greater, and 6 the less.
3. A won 25 of B.
4. 8 and 12.
5. 1^1 and ^{2}.
6. 3, 4, and 5; and $\frac{1}{2}(a+b-c)$ $\frac{1}{2}(a-b+c)$, and $\frac{1}{2}(b-a+c)$.
7. 387.
8. 8, 15, 2, and 50.
9. Each man, £1; each boy, 10s.
10. The daughter £2,000, and the son £800.
11. 180 half-guineas, and 22 crowns.
12. 2, 4, 7, and 9.
13. 6 and 9.
14. Greater = 43, and less = 15.
15. A, 28; B, 14; and C, 8.
16. He started with 3s. 9d., and borrowed 4s. 3d.
17. The woman, 1s. 6d.; the man, 2s. 8d.
18. Brandy, 15 gallons; cider, 21; and wine, 24.
19. A had 22, and B 20.
20. A, £60; B, £140; and C, £280.
21. The first, £200; second, £300; and third, £200.
22. 21 and 23.
23. 24 persons; each, 7s. Total, 8 guineas.
24. £26 and £9.
25. 16 and 8.
26. In 8 hours, 22 minutes, 24$\frac{2}{3}$ seconds.
27. 10 days.
28. 12 days.
29. 30 bushels of rye, and 42 of wheat.
30. 12 persons; 5s. each.
31. 12 crowns, and 8 half-guineas.
32. 4 hours with the stream, and 6 against it.
33. A has $\frac{1}{12}(23a-9b-8c)$; B has $\frac{1}{12}(21b-4c-6a)$; and C has $\frac{1}{12}(30c-4a-3b)$.
34. $a=3$; $b=-1$; and $c=-2$.
35. £51, £41, £21, £11, and £6, respectively.
36. $x=\dfrac{ce-bf}{ae-bd}$ and $y=\dfrac{af-cd}{ae-bd}$
37. 234.
38. No. of men $=\dfrac{12n-qn}{p-q}$; No. of women $=\dfrac{pn-12n}{p-q}$.
39. $\dfrac{(a-b)}{a^n-1}$.
40. 98 artillery; 196 cavalry; and 2,450 infantry.
41. £300.
42. A has 42, B has 66, and C has 102.
43. 15 ft. by 11 ft.
44. 22, and £5.
45. 75.
46. By water, 1,540; by foot, 880; and on horseback, 616 miles.
47. 87$\frac{1}{2}$ minutes, and 25 min.
48. 10 pounds.
49. 18 days, 10$\frac{1}{2}$ days, and 6$\frac{3}{4}$ days.
50. A, £46; B, £92; C, £41; and D, £05.
51. 63 oz.
52. 30 hours.
53. 90 lb. tea, and 120 lb. coffee.
54. 054.
55. 23s. and 20s.
56. 130 ducks, and 104 geese.
57. Man, 62 hours; woman 93 hours; and child, 155 hours.
58. £2,240.
59. 500.

EXERCISE 42.

1. $-8x^4y^3$.
2. $9b^m$.
3. $-4a^3y^n$.
4. a^3b^2.
5. $7(a+y)^n$.
6. $18x(a-b)^2$.
7. $5(x+y)^3+13x^2$.
8. $11a^2bc^3$.
9. $a^{2}b^{2}(1+b+a^{2}b^{4})+c^{2}y^{4}(c^{4}-1)$.
10. $15a^3+10b^2c^2$.
11. $4(xy-cm)^6$.

EXERCISE 43.

1. $-7b^n$.
2. $-b^2b^6$.
3. 0.
4. $2(a-b)^4$.
5. $5m(n+b)^2$.
6. $3x^2y^3+10y^3$.
7. $2x(b^2-8)^2$.
8. $(x^2+y^2)^2$.
9. $a^2b^2(1-a^2b^2)+x^2y^4(xn+1)$.
10. $x(a-b)^2$.
11. $\frac{1}{2}(x+y)^2$.

EXERCISE 44.

1. $a^4b^2k^3$.
2. $-6x^6xy^6$.
3. $4b^2h^3x^my^4$.
4. $a^3b^3y^4$.
5. $8a^{2n}$.
6. $4x^2$.
7. b^2y^2.
8. $a^3b^3y^3$.
9. $(b+h-y)^{n+1}$.
10. x^4-y^6.
11. $6x^3y+2x^2y-x^2(2+3y)+x$.
12. $2x^4+3x^3+3x^2-8x^2-4x-5$.
13. $y^{-(n+m+n)}$.
14. a^{-12}.
15. $-a^{-10}$.
16. $-a^{m+n}$.
17. $y^{-(n+2)}$.
18. a^3-y^2.
19. a^4-y^4.
20. a^6-y^6.
21. a^3-a^2.
22. $9a^2(x^2-y^2)^2$.
23. $\frac{1}{2}(a^2+b^2)^2$.
24. $10(a^4-b^4)$.
25. $x^4+2x^3y+2x^2y^2+2xy^3+y^4$.
26. a^3+32b^3.
27. $a^4+a^2(b-8)-8b$

EXERCISE 45.

1. $-3y^4$.
2. $6x^4$.
3. $b+3y^4$.
4. d.
5. a^{n+7}.
6. x^0 or 1.
7. y^m.
8. b^2.
9. $2x^n$.
10. a^{n+1}.
11. $4(b+x)^{n-3}$.

EXERCISE 46.

1. $a^{\frac{4}{3}}$ denotes the 4th power of the 3rd root of a, or the cube root of the 4th power of a.
2. $x^{\frac{3}{2}}$ denotes the square root of the cube of x.
3. $y^{\frac{8}{6}}$ denotes the 6th root of the 8th power of y.
4. $b^{\frac{7}{6}}$ denotes the 6th root of the 7th power of b.
5. $a^{\frac{3}{4}}$.
6. $d^{\frac{7}{2}}$.
7. $a^{0\cdot 25}$.
8. $a^{0\cdot 4}$.
9. $a^{0\cdot 6}$.
10. $a^{1\cdot 5}$.
11. $a^{0\cdot 75}$.
12. $a^{0\cdot 777}$.
13. $a^{1\cdot 666}$.
14. $a^{1\cdot 5714\ldots}$.

ELOCUTION.—IV.

[*Continued from p. 224.*]

ANALYSIS OF THE VOICE.

IF we observe attentively the voice of a good reader or speaker, we shall find his style of utterance marked by the following traits. His voice pleases the ear by its very sound. It is wholly free from affected suavity; yet, while perfectly natural, it is round, smooth, and agreeable. It is equally free from the faults of feebleness and of undue loudness. It is perfectly distinct in the execution of every sound in every word. It is free from errors of negligent usage and corrupted style in pronunciation. It avoids a measured rhythmical chant on the one hand and a broken irregular movement on the other. It renders expression clear by an attentive observance of appropriate pauses, and gives weight and effect to sentiment by occasional impressive cessations of voice. It sheds light on the meaning of sentences by the emphatic force which it gives to significant and expressive words. It avoids the "school" tone of uniform inflections, and varies the voice upward or downward, as the successive clauses of a sentence demand. It marks the character of every emotion

by its peculiar traits of tone; and hence its effect upon the ear, in the utterance of connected sentences and paragraphs, is like that of a varied melody in music, played or sung with ever-varying feeling or expression.

The analysis of the voice, for the purposes of instruction and practice in reading and declamation, may be extended, in detail, to the following points, which form *the essential properties of good style in reading and speaking:*—

1. Good "Quality" of Voice.	6. Appropriate Pauses.
2. Due "Quantity" of Loudness.	7. Right Emphasis.
3. Distinct Articulation.	8. Correct "Inflections."
4. Correct Pronunciation.	9. Just "Stress."
5. True Time.	10. "Expressive Tones."
	11. Appropriate "Modulation."

I. QUALITY OF VOICE.

The chief properties of a good voice are—

1. Roundness.	3. Versatility.
2. Smoothness.	4. Right Pitch.

1.—*Roundness.*

This property of voice is exemplified in that ringing fulness of tone which belongs to the utterance of animated earnest feeling, when unobstructed by false habit. It is natural and habitual in childhood; it is exhibited in all good singing, and in the properly cultivated style of public reading and speaking.

To obtain roundness and fulness of voice, it is exceedingly important that the student observe the following suggestions. Be attentive to the position of the body. No person can produce a full well-formed sound of the voice in a lounging or stooping posture. The attitude of the body required for the proper use of the voice is that of being perfectly upright, without rigidness. The head must never be permitted to droop; it should be held perfectly erect. The back must be kept straight, and the shoulders pressed backward and downward. The chest must be well expanded, raised, and projected; so as to make it as roomy as possible, in order to obtain full breath and full voice. Breathe freely and deeply; keep up an easy fulness of breath, without overdoing the capacity of your lungs. Make your utterance vigorous and full, by giving free play to the muscles situated below the bony part of the trunk; these should move energetically, in order to drive the breath upwards with due force, and thus give body to the sounds of the voice. Keep the throat freely open, by free opening of the mouth, so as to give capaciousness and rotundity to every sound. A round voice can never proceed from a half-shut mouth.

The large and full effect of vocal sound, produced by the due observance of the preceding directions, forms what is called in elocution the "orotund" (round, or, literally, round-mouthed) voice, which is considered the ample style of oratory, or public reading, in contrast with the limited utterance of private conversation. The attitude of body, and the position and action of the organs, demanded by "orotund" utterance, is likewise highly favourable to health and to easy use of the voice; while stooping and lounging postures, a sunken chest, and drooping head, tend both to suppress the voice and injure the organs, besides impairing the health.

Practice in the style of vehement declamation is the best means of securing a round and full tone. The following exercise should be repeatedly practised, with the attention closely directed to the management of the organs, in the manner which has just been described, as producing the "orotund," or resonant quality of voice.

Exercise on the "Orotund."

Who is the man that, in addition to the disgraces and mischiefs of the war, has dared to authorise, and associate with our arms, the tomahawk and scalping-knife of the savage?—to call into civilised alliance the wild and inhuman inhabitant of the woods?—to delegate to the merciless Indian the defence of disputed rights, and to wage the horrors of this barbarous war against our brethren?—My lords, we are called upon as members of this house, as men, as Christians, to protest against such horrible barbarity!—I solemnly call upon your lordships, and upon every order of men in the state, to stamp upon this infamous procedure the indelible stigma of the public abhorrence!

2.—*Smoothness of Voice, or "Purity" of Tone.*

Smoothness of voice, in reading and speaking, is the same quality which, in relation to vocal music, is termed "purity" of tone.

This property of voice consists in maintaining an undisturbed liquid stream of sound, resembling to the ear the effect produced on the eye by the flow of a clear and perfectly transparent stream of water. It depends, like every other excellence of voice, on a free, upright, and unembarrassed attitude of the body—the head erect, the chest expanded. It implies natural and tranquil respiration (breathing); full and deep "inspiration" (inhaling, or drawing in the breath); and gentle "expiration" (giving forth the breath); a true, and firm, but moderate exercise of the "larynx" (or upper part of the throat); and a careful avoiding of every motion that produces a jarring, harsh, or grating sound.

"Pure" tone is free from (1) the heavy and hollow note of the chest; (2) the "guttural," choked, stifled, or hard sound of the swollen and compressed throat; (3) the hoarse, husky, "harsh," "reedy," and grating style, which comes from too forcible "expiration," and too wide opening of the

throat; (4) the nasal twang, which is caused by forcing the breath against the nasal passage, and at the same time partially closing it; (5) the wiry, or *false* ring of the voice, which unites the guttural and the nasal tones; (6) the affected mincing voice of the mouth, which is caused by not allowing the due proportion of breath to escape through the nose. The natural, smooth, and pure tone of the voice, as exhibited in the vivid utterance natural to healthy childhood, to good vocal music, or to appropriate public speaking, avoids every effect arising from an undue preponderance, or excess, in the action of the muscles of the chest, of the throat, or of any other organ, and, at the same time, secures all the good qualities resulting from the just and well-proportioned exercise of each. A true and smooth utterance derives resonance from the chest, firmness from the throat, and clearness from the head and mouth.

Without these qualities, it is impossible to give right effect to the beauty and grandeur of noble sentiments, whether expressed in prose or in verse.

Childhood and youth are the favourable seasons for acquiring and fixing in permanent possession the good qualities of agreeable and effective utterance. The self-taught cannot exert too much vigilance, nor take too much pains, to avoid the encroachments of faulty habit in this important requisite to a good elocution.

The subjoined exercise should be frequently and attentively practised, with a view to avoid every sound which mars the purity of the tone, or hinders a perfect smoothness of voice.

Exercise in Smoothness and "Purity" of Voice.

No sooner had the Almighty ceased, but all
The multitude of angels, with a shout,
Loud as from numbers without number, sweet
As from blest voices uttering joy;—heaven rung
With jubilee, and loud hosannas filled
The eternal regions;—lowly reverent,
Towards either throne they bow; and to the ground,
With solemn adoration, down they cast
Their crowns, inwove with amaranth and gold.—
Then crowned again, their golden harps they took,
Harps ever tuned,—that, glittering by their side,
Like quivers hung, and with preamble sweet
Of charming symphony they introduce
Their sacred song, and waken raptures high.

The various passions and emotions of the soul are to a great extent indicated by the "quality" of the voice. Thus, the *malignant* and *all excessive* emotions, as, *anger*, *hatred*, *revenge*, *fear*, and *horror*, are remarkable for "guttural quality," and strong "aspiration," or "expiration," accompanying the vocal sound, and forming "impure" tone; substituting a "harsh," husky, aspirated utterance for the "orotund" or the "pure" tone; while *pathos*, *serenity*, *love*, *joy*, *courage*, take a soft and smooth "oral," or head tone, perfectly pure, or swelling into "orotund." *Awe*, *solemnity*, *reverence*, and *melancholy*, take a deep "pectoral" murmur; the voice resounding, as it were, in the cavity of the chest, but still keeping perfectly "pure" in tone, or expanding into full "orotund."

The young student cannot be too deeply impressed with the importance of cultivating early a pure and smooth utterance. The excessively deep "pectoral" tone sounds hollow and sepulchral; the "guttural" tone is coarse, and harsh, and grating to the ear; the "nasal" tone is ludicrous; and the combination of "guttural" and "nasal" tones is repulsive and extremely disagreeable. Some speakers, through excessive negligence, allow themselves to combine the "pectoral," "guttural," and "nasal" tones in one sound, for which the word *grunt* is the only approximate designation that can be found. Affectation or false taste, on the other hand, induces some speakers to assume an extra fine, or double-distilled, "oral" tone, which minces every word in the mouth, as if the breast had no part to perform in human utterance.

The tones of serious, serene, cheerful, and kindly feeling, are nature's genuine standard of agreeable voice, as is evinced in the utterance of healthy and happy childhood. But prevalent neglect permits these to be lost in the habitual tones of boys and girls, men and women. Faithful advisers may be of much service to young students in this particular.

3.—*Versatility or Pliancy of Voice*

signifies that power of easy and instant adaptation, by which it takes on the appropriate utterance of every emotion which occurs in the reading or speaking of a piece characterised by varied feeling or intense passion.

To acquire this invaluable property of voice, the most useful course of practice is the repeated reading or reciting of passages marked by striking contrasts of tone, as loud or soft, high or low, fast or slow.

The following exercises should be repeated till the student can give them in succession, with perfect adaptation of voice in each case, and with instantaneous precision of effect.

Exercises for Versatility or Pliancy of Voice.

Very Loud.

And dar'st thou, then,
To beard the lion in his den,—
The Douglas in his hall?
And hop'st thou hence unscathed to go?
No! by St. Bride of Bothwell, no!—
Up, drawbridge, groom! What! warder, ho!
Let the portcullis fall!

Very Soft.

I've seen the moon climb the mountain's brow,
I've watched the mists o'er the river stealing,—
But ne'er did I feel in my breast till now
So deep, so calm, and so holy a feeling:—
'Tis soft as the thrill which memory throws
Athwart the soul in the hour of repose.

Very Low.

I had a dream, which was not all a dream:
The bright sun was extinguished; and the stars
Did wander darkling in the eternal space,
Rayless, and pathless; and the icy earth
Swung blind and blackening in the moonless air.

Very High.

I awoke:—where was I?—Do I see
A human face look down on me?
And doth a roof above me close?
Do these limbs on a couch repose?
Is this a chamber where I lie?
And is it mortal, yon bright eye,
That watches me with gentle glance?

Very Slow.

Of old hast Thou laid the foundation of the earth; and the heavens are the work of Thy hands. They shall perish, but Thou shalt endure; yea, all of them shall wax old, like a garment; as a vesture shalt Thou change them, and they shall be changed: but Thou art the same; and Thy years shall have no

Very Quick.

I am the Rider of the wind,
The Stirrer of the storm!
The hurricane I left behind
Is yet with lightning warm;—
To speed to thee, o'er shore and sea
I swept upon the blast.

4.—*True Pitch of Voice.*

The proper pitch of the voice, when no peculiar emotion demands high or low notes, is—for the purposes of ordinary reading or speaking—a little below the habitual note of conversation, for the person who reads or speaks. Public discourse, being usually on graver subjects and occasions than mere private communication, naturally and properly adopts this level.

But, through mistake or inadvertency, we sometimes hear persons read and speak on too low a key for the easy and expressive use of the voice, and sometimes, on the other hand, on a key too high for convenient or agreeable utterance.

The following sentences should be repeated till the note on which they are pitched is distinctly recognised, and perfectly remembered, so as to become a key to all similar passages.

Exercise on Middle Pitch.

In every period of life, the acquisition of knowledge is one of the most pleasing employments of the human mind. But in youth, there are circumstances which make it productive of higher enjoyment. It is then that everything has the charm of novelty; that curiosity and fancy are awake, and that the heart swells with the anticipations of future eminence and utility.

Contrast this pitch with that of the pieces before quoted, as examples of "high" and "low."

II. DUE QUANTITY, OR LOUDNESS.

The second characteristic of good reading is the use of that degree of loudness, force, "volume," or "quantity," of voice which enables those to whom we read or speak to hear without effort every sound of the voice; and which, at the same time, gives that degree of force which is best adapted to the utterance of the sentiments which are read or spoken.

The failure, as regards loudness, is usually made on passages of moderate force, which do not furnish an inspiring impulse of emotion, and which depend on the exercise of judgment and discrimination, rather than of feeling.

It is of great service, however, to progress in elocution, to possess the power of discriminating various degrees of force which the utterance of sentiment requires. The extremes of very "loud" and very "soft," required by peculiar emotions, have been exemplified in the exercise of "versatility" of voice.

There are three degrees of loudness, all of great importance to the appropriate utterance of thought and feeling, required in the usual forms of composition. These are the following:—"Moderate," "forcible," and "impassioned." The first, the "moderate," occurs in the reading of plain narrative, descriptive, or didactic composition, addressed to the understanding rather than to the feelings; the second, the "forcible," is exemplified in energetic declamation; the third, the "impassioned," occurs in the language of intense emotion, whether in the form of poetry or of prose.

Exercise in "Moderate" Force.

An author represents Adam as using the following language:—"I remember the moment my existence commenced: it was a moment replete with joy, amazement, and anxiety. I neither knew what I was, where I was, nor whence I came. I opened my eyes: what an increase of sensation! The light, the celestial vault, the verdure of the earth, the transparency of the waters, gave animation to my spirits, and conveyed pleasures which exceed the powers of utterance."

"Declamatory" Force.

Advance, then, ye future generations! We bid you welcome to this pleasant land of the Fathers. We bid you welcome to the healthful skies and the verdant fields of New England. We greet your accession to the great inheritance which we have enjoyed. We welcome you to the blessings of good government and religious liberty. We welcome you to the treasures of science and the delights of learning. We welcome you to the transcendent sweets of domestic life, to the happiness of kindred, and parents, and children. We welcome you to the immeasurable blessings of rational existence, the immortal hope of Christianity, and the light of everlasting truth!

"Impassioned" Force.

It is strange!—it is dreadful!—Shout, Tyranny, shout
'Through your dungeons and palaces, "Freedom is o'er!"—
If there lingers one spark of her fire, tread it out,
And return to your empire of darkness once more.

III.—DISTINCT ARTICULATION.

Correct articulation is the most important exercise of the voice and of the organs of speech. A reader or speaker, possessed of only a moderate voice, if he articulates correctly, will be better understood, and heard with greater pleasure, than one who vociferates. The voice of the latter may, indeed, extend to a considerable distance; but the sound is dissipated in confusion: of the voice of the former not the smallest vibration is wasted—every sound is perceived at the utmost distance to which it reaches; and hence it even penetrates farther than one which is loud, but badly articulated.

In just articulation the words are not hurried over, nor precipitated syllable over syllable; nor, as it were, melted together into a mass of confusion; they are neither abridged nor prolonged; nor swallowed, nor forced, and, if we may so express ourselves, shot from the mouth; they are not trailed or drawled, nor let slip out carelessly so as to drop unfinished. They are delivered out from the lips, as beautiful coins newly issued from the mint, deeply and accurately impressed, perfectly finished, neatly struck by the proper organs, distinct, sharp, in due succession, and of due weight.

This department of correct reading belongs properly to the stage of elementary lessons. But negligence in general habit and remissness in early practice are extensively the causes of an imperfect articulation.

A paragraph or two of every reading lesson should, previous to the regular exercise, be read *backward*, for the purpose of arresting the attention, and securing every sound in every word.

The design of the present lessons does not admit of detail in the department of elocution now under consideration. The importance, however, of a perfectly distinct enunciation can never be impressed too deeply on the mind of the student. An exact articulation is more conducive than any degree of loudness to facility of hearing and understanding. Young readers should be accustomed to pronounce every word, every syllable, and every letter with accuracy, although without laboured effort. The faults of skipping, slighting, mumbling, swallowing, or drawling the sounds of vowels or of consonants are not only offensive to the ear, but subversive of meaning, as may be perceived in the practice of several of the following examples.

Examples.

1. That *lasts till* night: that *last still* night.
2. He can debate *on either* side of the question: he can debate *on neither* side of the question.
3. The steadfa*st st*ranger in the fore*sts st*rayed.
4. Who ever imagined such *an ocean* to exist?—Who ever imagined such *a notion* to exist?
5. His *cry moved* me: his *crime moved* me.
6. He could *pay nobody*: he could *pain nobody*.
7. Up the *h*igh *h*ill *h*e *h*eaves a *h*uge round stone.
8. Tho' *oft the ear the* open vowels tire.
9. Heaven's fir*st st*ar alike ye see.

The following description of a whale chase, taken from Goodsir's "Arctic Voyage," will furnish a useful exercise in distinctness of articulation. Read it with animation and "moderate force," but not too fast.

We pulled in the direction in which the whale was "heading," where the rest of the boats already were; before we got up to them, she had made her appearance at the surface; a second boat had got fast to her, and just in time, as she was seen to be "loose" from the first. She did not take out much line from this boat, but remained away a considerably longer time than usual, greatly to our astonishment, until we found that she was "blowing" in some holes in the floe, a good distance from the edge of it. One of the harpooners immediately proceeded over the ice with a hand-harpoon, trailing the end of the line with him, assisted by part of his crew, and from the edge of the hole drove his weapon into the body of the poor whale; whilst some of the others following plied the bleeding wretch with their long lances, so that she was soon obliged to betake herself again to the open water outside the floe. Here more of her enemies were waiting, for one boat was immediately upon her, and a gun-harpoon was at once driven almost out of sight into her huge side, which was already bristling with weapons. Our boat was on her very back as she dived with an unwieldy roll, which sent it surging gunwale under, taking the line whistling out for a score of fathoms, until the harpooner, knowing she was pretty well exhausted, stopped her way by taking three or four turns round the "boltard." But every few seconds she would make a start, drawing the boat almost head under, until the line was permitted to run out again, which, as it did so, made a grinding, burring noise, eating deep into the hard lignum vitæ of the boltard, enveloping the harpooner in smoke, and causing the most distinct smell of burning, which was only prevented from actually taking place by the line-manager throwing water constantly on it.

Again she appeared at the surface, but far exhausted; still she made a strong fight for it, lashing about with her tail and fins in fury whenever she seemed to have regained breath. It was no very pleasant sight to see her tail quivering high up in the air, within but a short distance of us, and coming down on the water with a loud, sharp crack, like the report of a dozen rifles, and which, had it alighted on any of our boats, had power sufficient to have converted their timbers into something very like lucifer matches. A few more lances soon settled her; and ere long she was rolling on her back. The usual cheers of triumph were given, and we had time to breathe and shake ourselves, for it may be believed we had not escaped the showers of spray which the defunct had sent about so liberally. The water far around us was dyed with blood, and covered with a thick pellicle of oil, upon which the Mollys were as busy as they could be, whilst the edges of the ice, as far as we could see, were deeply crimsoned; and a hummock, on the edge of the floe, beside which the final struggle had taken place, was from the summit downward streaked with the black blood which the last few blasts of the dying monster had sent over it.

BOTANY.—XIX.

[*Continued from p.* 2?8.]

GAMOPETALÆ (*continued*).

THE cohort *Lamiales* have exstipulate leaves; pentamerous and usually monosymmetric flowers with ringent bilabiate corolla; epipetalous, didynamous stamens, the posterior one being abortive or suppressed; and two carpels, generally resulting in a

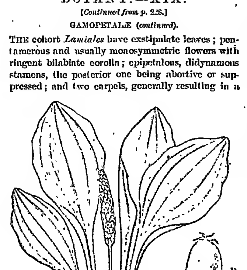


Fig. 85.—THE GREATER PLANTAIN (*Plantago major*). A, Young plant. B, Flower and bract. C, Flower in section. D, Fruit bursting.

quadrilocular regma, each loculus being one-seeded. The typical formula is $\downarrow$(5).[(5).4†1.](2). The cohort includes the large order *Labiatæ*, the *Verbenaceæ*, and the somewhat anomalous *Plantaginaceæ*. The *Labiatæ*, the fifth largest order among Dicotyledons, comprising, as they do, nearly 3,000 species, under 140 genera, are mostly aromatic herbs with square stems, opposite and decussate leaves and flowers in verticillasters. The calyx is persistent and has its odd lobe posterior; the two posterior petals generally form a helmet-like (*galeate*) hood, and the three anterior ones a lip or landing-place for insects (*labellum*), all five being united in a tube below. In the stamens the connective is usually well developed, especially in *Salvia*, in which genus two stamens are aborted and the two remaining have short stout filaments on either side of the entrance to the corolla-tube, on which the long connectives can be turned, as on a ball-and-socket joint, carrying two, often united, barren anther-loculi, one on each of the short lower arms of the levers and the two polliniferous ones on the long upper arms. This is an arrangement for cross-pollination by insects. The head of a bee, seeking with its proboscis for honey secreted at the base of the corolla-tube, rotates the connectives until the fertile anther-loculi strike the pollen on to its back, and then, the flower being protandrous, on the bee's visiting a more mature blossom, the diverging stigmatic lobes, occupying the same position as the anther-loculi when rotated, sweep off the pollen. The gynæceum closely resembles that of *Boraginaceæ*, the style, as in that order, being gynobasic and bifurcating at the stigma. There is little or no perisperm. *Labiatæ* are mostly natives of temperate climates, and, though many of them, such as *Salvia*, are grown for their bright flowers, the plants of the order derive most of their importance from their essential oils and the stearoptenes or camphors dissolved in them. Mint (*Mentha viridis*), sage (*Salvia officinalis*), and thyme (*Thymus vulgaris*) are well-known pot-herbs; lavender (*Lavandula vera*), rosemary (*Rosmarinus officinalis*), and patchouli (*Pogostemon Patchouli*) are perfumes; and menthol, obtained from several varieties of mint and used in neuralgia, is the most important of the camphors. (*See* Fig. 63, C—I, Vol. IV., p. 289.)

The *Verbenaceæ* are a large order, chiefly tropical, differing from *Labiatæ* mainly in having a terminal style, and including, besides the wild vervain (*Verbena officinalis*) and the garden verbena of South America (*V. Aubletia*), the white mangroves (*Avicennia*) of Brazilian coasts, and the valuable timber tree the teak (*Tectona grandis*) of the East Indies.

The *Plantaginaceæ*, the plantains, are a small group of herbs with rosulate radical leaves and spicate scapes of small flowers, which are in some cases monœcious and are apparently wind-pollinated. The flowers are tetramerous, the fifth posterior sepal and stamen being suppressed and the two posterior petals cohering, as in *Veronica*. The placentation is basal or free-central. The nearest affinities of the order are not clear. The spikes of unripe capsules of *Plantago major* are sold as food for cage-birds (Fig. 85).

INCOMPLETÆ.

In many respects the lowest sub-class of Dicotyledons are the *Incompletæ*. They are often, but less appropriately, called *Monochlamydeæ* or *Apetalæ*, as having generally only one perianth-whorl, which is sepaloid; but as this is sometimes absent, they

ING BIRD FERTILISING A BRUGMANSIA

are then really achlamydeous. Two whorls are occasionally present, but both are then generally green. The flowers are often unisexual, and no doubt many of the forms included in the group are merely reduced or degraded types of *Thalamifloræ* and *Calycifloræ*. As our knowledge increases and our scheme of classification is revised, these will be removed to the neighbourhood of their true allies; but even then a residue of lowly forms, perhaps truly primitive or ancestral, would probably remain. For the present, we may subdivide the sub-class into the two series *Epigynæ* and *Hypogynæ*.

The series *Epigynæ*, characterised by an inferior ovary, includes three cohorts, the *Santalales*, *Asarales*, and *Quernales*. The *Santalales* are parasites, with leaves either absent, or simple and entire; one whorl of stamens superposed upon the perianth-leaves; a unilocular ovary; and neither primine nor secundine to the ovules. The cohort includes the *Balanophoraceæ*, brown root-parasites on various dicotyledonous trees, found chiefly among the mountains of the tropics, but including *Cynomorium coccineum*, the styptic so-called "Fungus melitensis" of Malta; the *Santalaceæ* and the *Loranthaceæ*. The *Santalaceæ* are root-parasites, but contain chlorophyll. The ovules are suspended from the apex of a free-central placenta, and are remarkable for the protrusion of the embryo-sac before fertilisation so as to meet the pollen-tube, the entire embryo forming in the protruded portion. There is one uncommon British species, the bastard toad-flax, *Thesium linophyllum*; but their scented wood renders the tropical sandalwoods (*Santalum*) more familiar. The *Loranthaceæ*, of which the mistletoe (*Viscum album*) is a well-known representative, are woody branch-parasites, branching dichasially, with evergreen, opposite, exstipulate leaves. The mistletoe is diœcious. The male flower consists of four leaves, each bearing a multilocular anther sessile on its upper surface. The pistillate flowers are produced three together on the apex of a branch, and each consists of four leaves and an ovary. Not until after pollination do the ovules appear, each being an embryo-sac produced from a single cell at the base of the carpel. Two or more embryos are often formed in one embryo-sac. The fruit is a berry, which adheres by its viscid pericarp to the bark of trees, and when

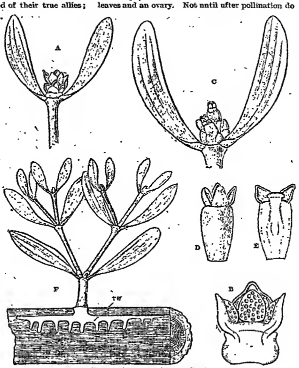


Fig. 86.—MISTLETOE (*Viscum album*).
A, Staminate flowers. B, One staminate flower in section, mag. 12 times. C, Pistillate flowers. D, One pistillate flower, and E, the same in section, mag. 8 times. F, Plant attached to host-plant by haustorium (*rw*) beneath the bark.

the seed, which is albuminous, germinates, its radicle penetrates the cortex and becomes naturally grafted into the sap-wood of the host-plant (Fig. 86).

The small cohort *Asarales* includes the orders *Rafflesiaceæ* and *Aristolochiaceæ*. The *Rafflesiaceæ* are parasites, without chlorophyll and with few or no foliage-leaves, which attach themselves to roots, mainly in the tropics. *Rafflesia Arnoldi* consists of a sub-sessile flower, nearly three feet in diameter and weighing fourteen pounds, springing directly from the roots of *Cissus angustifolia*, a vine in Malayan forests. Its perianth consists of five leaves, so resembling raw or putrescent meat in colour and smell as even to be fly-blown, and having a ligular corona. The *Aristolochiaceæ* are mostly climbing shrubs, most numerous in tropical America. Some species of *Aristolochia* have large cordate leaves, a monosymmetric, helmet-shaped three-leaved perianth, sometimes luridly spotted

FIG. 87.—FLOWERING BRANCH AND EMPTY CUPULE OF BEECH (*Fagus sylvatica*).

and fetid, and large enough to be used as caps by Indian boys in Brazilian forests. The six stamens adhere to the style, and the ovary is six-chambered. Several species are, in various countries, reputed antidotes for snake-bite (*alexipharmics*).

The more important cohort *Quernales* consists of trees with diclinous flowers, the staminate ones at least being in catkins, the perianth green and inconspicuous, the fruit one-seeded, and the seed exalbuminous. Comprising the three orders *Juglandaceæ*, *Corylaceæ*, and *Cupuliferæ*, this cohort contains the most important broad-leaved and hard-wooded trees of temperate climates. The *Juglandaceæ*, including the walnuts (*Juglans*) and hickories (*Carya*), have scattered, pinnate, exstipulate leaves; monœcious flowers; ovary of two carpels containing one erect atropous ovule, giving rise to a drupaceous fruit with fleshy dehiscent epicarp and stony two-valved endocarp (the "shell") and a seed with large sinuous, oily cotyledons. In both genera the timber and edible seeds are valuable. The whole fruit of the walnut is pickled when young. The *Corylaceæ* have distichous, simple, pinnately-veined leaves with deciduous stipules; monœcious flowers in distinct catkins, with little or no perianth, but a leafy cupule, formed of coherent bracteoles, round the nut; stamens with bifurcating filaments; and an ovary with two loculi, one of which is sterile, whilst the other contains two anatropous ovules. The chief genera are *Corylus*, the hazel, and *Carpinus*, the hornbeam. The *Cupuliferæ*, for which perhaps the name *Quercineæ* would be less ambiguous, include the oaks (*Quercus*), beeches (*Fagus*), and chestnuts (*Castanea*). They differ from the *Corylaceæ* in having a small perianth of five or six leaves, unforked stamens, and a trilocular ovary with two anatropous ovules in each chamber. The cork oak of Southern Europe (*Quercus Suber*) forms a thick periderm, and, like many other species, is evergreen. The leaves of all oaks are pentastichous. The catkins bear scattered flowers with five or more stamens in the male ones and the pistillate ones surrounded by the imbricate leaves of the cupule. This "acorn-cup" in *Q. Ægilops* is large, and is used in dyeing under the name valonia. The bark of our British *Q. Robur* and other species is rich in tannin, as are also the galls produced by the puncture of certain insects. "Oak-apples" are merely a kind of gall. In *Fagus*, the beech, the bark is smooth; the leaves are distichous; the winter-buds, long and pointed; the staminate catkins, dense; and the pistillate flowers, in pairs, enclosed in a bristly cupule which splits into four valves liberating the three-cornered fruits (Fig. 87). Beeches are remarkable for their wide geographical distribution, occurring not only throughout the north temperate region, but also in the Andes, Fuegia, Tasmania, and New Zealand. *Castanea*, the chestnut, has

glossy, serrate leaves and very long lax catkins, sometimes consisting of both staminate and pistillate flowers. Each bract bears in its axil seven staminate or three pistillate flowers, the latter enclosed in one prickly cupule, which splits into four valves. The fruits, with their brown leathery pericarps, are surmounted by the limb of the perianth and the styles. They must not be confused with the seeds of the horse-chestnut (*see* p. 88, *supra*). Throughout the order five out of the six ovules in each ovary generally come to nothing.

The series *Hypogynæ* comprises seven cohorts, the *Nepenthales*, *Chenopodiales*, *Daphnales*, *Euphorbiales*, *Amentales*, *Urticales*, and *Piperales*. The first of these is a remarkable group isolated in structure, containing only the one order *Nepenthaceæ*, which comprises only the one genus *Nepenthes*, the pitcher-plants, natives of Madagascar, the Seychelles, India, Malaysia, Borneo, Australia, and New Caledonia. They are clambering shrubby plants, bearing remarkable tendril-like structures terminated by glandular pitchers at the apices of their leaves. These pitchers secrete a watery fluid which, on insects or other nitrogenous bodies falling into it, becomes acid and exerts a true digestive action, containing zymases and generating peptones (*see* Vol. I., p. 385). The throat of the pitcher is smooth and slippery above, with downward-pointing hairs below.

The *Chenopodiales* are herbs and shrubs with flowers usually polysymmetric and bisexual, perianth imbricate, ovary unilocular and one basal ovule. They include the orders *Chenopodiaceæ*, *Amarantaceæ*, and *Polygonaceæ*. The *Chenopodiaceæ*, or goose-foot tribe, have exstipulate leaves, a sepaloid perianth, and a usually albuminous seed, the typical formula being 5.0.5.(2). The order includes the spinach, *Spinacia oleracea*, and other species, and the beets. *Beta rubra* is the red beetroot; *B. alba*, the white beet, is the species grown on the Continent for the manufacture of sugar; and *B. vulgaris*, var. *Cycla*, is the mangel-wurzel.

The *Amarantaceæ* differ mainly in their membranous and often coloured bracteoles and sepals, the dense inflorescences of which give the names love-lies-bleeding and prince's-feathers to species of *Amarantus*, and that of cock's-comb to *Celosia cristata*, in which the branches of the inflorescence are naturally "fasciated" or grown together into a flattened mass.

The *Polygonaceæ* derive their name from the swollen nodes and "many-kneed" stems of the genus *Polygonum*, the knot-grasses. The leaves are mostly simple and scattered, with a well-developed sheath and ochreate stipules; the flowers have a trimerous symmetry and a more or less persistent perianth; and the fruit is a trigonal caryopsis. Thus, the genus *Rumex*, including the docks and sorrels, several species of which are cultivated for their acidulous leaves, which contain oxalic and malic acids, has the formula $3.3.3^{\times 2} + 0.(3)$. *Rheum*, including *R. palmatum*, the so-called "Turkey" rhubarb, with a purgative root, and *R. Rhaponticum*, the garden rhubarb, with pleasantly acid petioles now largely used for food, has the formula $3.3.3^{\times 2} + 3.(3)$. *Polygonum Fagopyrum*, the buckwheat, is grown for its mealy perisperm.

The *Daphnales* are mostly trees or shrubs, with simple and often evergreen or aromatic leaves, polysymmetric flowers, two whorls of perigynous

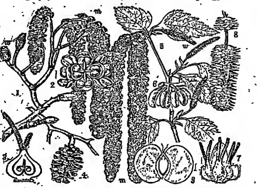


Fig. 88.—1–4, THE ALDER (*Alnus glutinosa*): 1, branch with male (*m*) and female (*w*) catkins; 2, male flower, enlarged; 3, ovary, in section; 4, ripe cone. 5–9, THE BIRCH (*Betula alba*): 5, branch with male (*m*) and female (*w*) catkins; 6, male flower, enlarged; 7, female flowers with bract; 8, fruit catkin, with part of rachis bared; 9, ripe fruit in section.

stamens and one anatropous ovule. The cohort includes the *Thymelæaceæ*, the *Proteaceæ*, the *Lauraceæ*, and the *Myristicaceæ*. The *Thymelæaceæ* have an exceptionally tough bast, furnishing useful fibres, as, for example, *Lagetta lintearia*, the lace-bark of the West Indies. Of our two British species, *Daphne Laureola*, the spurge-laurel, is an evergreen with sweet-scented greenish flowers opening in January, and the much rarer *D. Mezereum* is deciduous, its pink blossoms being produced precociously (*i.e.*, before its leaves) in February or March. The formula in this genus is $(4).0.4 + 4.1$.

The *Proteaceæ*, now almost confined to Australia and South Africa, derive their name from the varied or protean form of their coriaceous leaves.

Many of them have showy crowded inflorescences.

The *Lauraceæ*, a mainly tropical order of evergreen aromatic trees and shrubs, have often polygamous flowers with several whorls of stamens which have a remarkable operculate dehiscence by two or four valves. *Laurus nobilis*, the bay, a native of Southern Europe, must not be confused with *Prunus Laurocerasus*, the tree commonly called a laurel in England, which belongs to the *Rosaceæ*. One genus *Cassytha*, the dodder-laurels, consists of twining leafless parasites resembling *Cuscuta* in habit. Cinnamon and cassia are the barks of species of *Cinnamomum*; camphor is distilled from *Camphora officinarum*; and *Nectandra Rodiæi* is the green-heart of Demerara.

Myristicaceæ, the nutmeg tribe, are mostly natives of the Malay Archipelago, especially the Moluccas. Their fleshy two-valved capsules contain one seed, the nutmeg, invested by a fleshy, scarlet, branching aril, known as "mace." The oily seed has a very ruminate albumen from the ingrowth of the testa, giving it the familiar mottled appearance in cross-section.

The *Euphorbiales*, an isolated cohort, include only the one large order *Euphorbiaceæ*, the spurge tribe, the fourth largest dicotyledonous order, comprising over 3,000 species, in 204 genera. They have mostly an abundant white acrid latex, often purgative or poisonous, and containing rubber. Many African species have spinous cactus-like stems. The leaves are usually scattered and stipulate and the flowers diclinous. The fruit is usually a trilocular regma, dehiscing into three cocci from a rudimentary carpophore. In the world-wide genus *Euphorbia*, out of the 700 species, of which about a dozen are British, the flowers are collected into monœcious inflorescences consisting of several male and one female flower enclosed in a cup-like involucre or *cyathium*. Round the margin of this cyathium are yellow crescent-shaped glands. The male flower consists of a pedicel bearing one stamen, from which it is separated by an articulation with a minute bract or a perianth. The female flower consists of the trilocular ovary on a pendulous pedicel. The very common dog's mercury (*Mercurialis*) has diœcious racemes, a three-leaved perianth, eight to twenty stamens, and only two carpels. In this genus and in the box (*Buxus*) the juice is not milky. The wood of the latter is invaluable for engraving. The seeds of the African *Ricinus communis* yield castor-oil; and those of species of the Indian *Croton* yield croton-oil, both being purgative. In South America *Sapium* and *Hevea* yield caoutchouc, and the large root of the poisonous *Jatropha Manihot*, the cassava, yields, when granulated, the pure starch known as tapioca.

The *Amentales*, or catkin-bearers, present in their leading characteristic a close resemblance to the epigynous *Quernales*. The cohort includes two chief orders, the *Betulaceæ* and the *Salicaceæ*. The *Betulaceæ* are trees or shrubs with scattered, simple, pinnately-veined leaves having caducous stipules. The flowers are monœcious, in distinct catkins, the male having a perianth of minute scales and four stamens or two bifurcating ones, whilst the female have no perianth, consisting only of a bilocular ovary with one ovule in each loculus. In the fruit one loculus is aborted. *Betula*, the birches, forest-trees of northern temperate latitudes, have a periderm marked by large transverse lenticels and peeling off in strips; a sugary sap; pendulous catkins; and three two-winged samaras in the axils of each of the deciduous three-lobed catkin-scales. *Alnus*, the alders, have their female catkins erect, and the scales become woody and remain, like a little cone, on the tree after the fall of the fruits; and these fruits are not winged. Dwarf forms of both genera occur in the Arctic regions (Fig. 88).

The *Salicaceæ* are mainly a northern group, growing especially in damp places, and are all woody plants. Their bark contains the bitter alkaloid salicine. The leaves are scattered, simple, and stipulate, and the flowers are diœcious. In *Salix*, the willows, a genus rich in species and hybrids, each flower in the erect catkins, whether male or female, is in the axil of a simple bract, the stamens being from two to twelve in number; whilst in the only other genus, *Populus*, the poplars, the catkins droop, the bracts have a cut margin, there is a cup-shaped perianth, and the stamens vary in number from four to thirty in a flower. In both genera the fruit is one-chambered with two parietal placentas bearing numerous seeds each furnished with a long silky coma of hairs. The catkin-bearing shoots of willows are popularly known in England about Eastertide as "palm." *Populus tremula*, the aspen, owes the constant movement of its leaves in the breeze to the vertical flattening of their long slender stalks.

The large cohort *Urticales* have mostly diclinous flowers with some perianth, the stamens superposed on the perianth-segments, and the ovary one-chambered, with one ovule, but two styles. The cohort includes the order *Platanaceæ*, in many respects apparently related to the *Amentales*, and the *Urticaceæ*. *Platanaceæ* comprise only the one genus *Platanus*, the planes, timber-trees of the northern hemisphere with a periderm flaking off in squarish pieces; scattered, palmately-lobed, stipulate leaves, the bases of which cover the buds, and

monœcious flowers in globular catkins on distinct branches. The catkins give the trees their American name "button-wood." The flowers are merely surrounded by bristles, and the fruit is an achene.

The order *Urticaceæ* is made by Bentham to include eight tribes, which other botanists consider distinct orders. Among these are the *Ulmeæ*, *Cannabineæ*, *Moreæ*, *Artocarpeæ*, and *Urticeæ*. The *Ulmeæ*, or elms, are trees with distichous, simple, oblique, pinnately-veined leaves, with caducous stipules, having their flowers in lateral glomerules on the branches, bisexual, and often precocious. There is a campanulate, four or five-lobed, persistent perianth, with a stamen opposite each lobe, and a two-chambered ovary, of which one loculus becomes aborted, the fruit being a samara. The *Cannabineæ* include *Cannabis sativa*, the hemp, and *Humulus Lupulus*, the hop. Their lower leaves are opposite and palmate or palmately-lobed, with persistent stipules, and their flowers are diœcious. The male ones have five sepals and five stamens: the female ones have a tubular perianth. The fruit is a caryopsis. The bast of the hemp is used for cordage, and its fruits are oily. In the hop, a twining plant, the female inflorescence is a cone-like "strobilus" with membranous bracts, which are studded with yellow glands containing the bitter principle lupulin.

The *Moreæ* and *Artocarpeæ*, or mulberries, figs, and bread-fruits, are trees with a milky latex, often containing rubber, scattered leaves and generally monœcious flowers. In *Morus*, the mulberry, the female flowers are in a close raceme, and the four perianth-leaves of each flower become fleshy, enveloping the dry capsular fruit, and turn red and purple, ultimately touching so as to form one "mulberry," an infrutescence. In *Ficus* the flowers of both sexes are enclosed in a concave fleshy and edible common receptacle so as to form a capitulum. There are leafy bracts above and below this structure, and it ripens like a true fruit, changing colour and forming sugar; but the true ovaries within are often not fertilised. *F. Carica* is the fig; *F. indica*, the banyan (Vol. III., p. 112); *F. religiosa*, the peepul; and *F. elastica*, the india-rubber. In *Artocarpus*, the bread-fruit of the Pacific, the flowers are crowded on an edible fleshy peduncle, many pounds in weight. The *Urticeæ* or nettles are noticeable for their stinging hairs, containing formic acid. Their leaves are scattered and their flowers mostly unisexual. *Bœhmeria*, the Rheea or grass-cloth, has valuable bast.

The cohort *Piperales* with achlamydeous and usually bisexual flowers in a spike or spadix, and a seed containing both perisperm and metasperm (endosperm), contains only one important family, the mainly tropical *Piperaceæ*. These have a single erect atropous seed in a unilocular ovary. The unripe fruits of the climbing East Indian *Piper nigrum*, when dried, constitute black pepper; the same fruit, when ripe, with its pericarp removed, being white pepper.

FRENCH.—XXIX.

[*Continued from p. 284.*]

THE REPETITION OF ADVERBS.

THE adverbs of comparison, *plus*, *moins*, must be repeated before every adjective which they modify:—

Il est *moins* paresseux et *moins* obstiné que son frère.	*He is less idle and obstinate than his brother.*

In English the adverb is not usually repeated unless it is intended to convey emphasis.

These adverbs, and the adverbs of quantity, need not be repeated before every noun; but the preposition *de*, which must always come between *peu*, *trop*, *beaucoup*, *tant*, *plus*, *moins*, *autant*, *assez*, *combien*, and a noun or an adjective used substantively, must be repeated in every case:—

Il n'y aurait pas tant *de* peine et *de* misère dans ce monde. . .	*There would not be so much trouble and misery in the world . . .*
Ce libraire a beaucoup *de* bons et *de* mauvais ouvrages dans son magasin.	*This bookseller has many good and bad books in his establishment.*

ADVERBS OF NEGATION.

The negation is composed of *ne* placed before the verb, and *pas* or *point*, *jamais*, etc., after it in the simple tenses. The second negative comes between the auxiliary and the verb in the compound tenses:—

Le ciel sur nos souhaits *ne* règle *pas* les choses. CORNEILLE.	*Heaven does not regulate things according to our wishes.*
Rome *n*'attache *point* le grade à la noblesse. CORNEILLE.	*Rome does not by any means confine offices to the nobility.*
L'estime est le vrai principe de la considération, qui *n*'est *pas* toujours attaché aux dignités. FONTENELLE.	*Esteem is the true principle of consideration, which is not always attached to offices.*
Les rois *ne* sont *point* protégés par les lois. CHÉNIER.	*Kings are by no means protected by laws.*
Il *n*'a *jamais* dit cela.	*He has never said that.*
Je *ne* chante *guère*.	*I do not sing much.*

It will be seen in the above examples that the negative *point* is stronger than *pas*. The meaning of these two words, which are in fact substantives used adverbially, and express the signification of the negative *ne*, will sufficiently explain this:

N'allez pas means *n'allez un pas*, do not go or move *one pace* or *step*. *N'allez point* means *n'allez un point*, do not go or move *a point* or *dot*.

Pas, as you know, is a corruption of the Latin *passum*, *point* of the Latin *punctum*.

When the verb is in the present or in the past of the infinitive, the two negatives may be put together before the verb, or the verb between them:—

Pour *ne pas* sortir; *or* pour *ne* sortir *pas*.	*In order not to go out.*
Pour *ne jamais* avoir menti; *or* pour *n'*avoir *jamais* menti.	*For never having told a lie.*

The first of these two constructions is the most generally used.

The second negative may be suppressed after the verbs *pouvoir*, *oser*, *savoir*, and *cesser*:—

Non, deesse; je *ne* puis souffrir qu'un de leurs vaisseaux fasse naufrage. FÉNELON.	*No, goddess; I cannot suffer that a single one of their vessels perish.*
Dans son appartement elle n'osait rentrer. VOLTAIRE.	*She durst not re-enter her apartment.*
Qui vit haï de tous *ne* saurait longtemps vivre. CORNEILLE.	*He who lives hated by all cannot exist long.*
La liberte *ne* cesse d'être aimable. CORNEILLE.	*Liberty cannot cease to be worthy of love.*

Pas or *point* is not used when the verb is modified by another negative word, such as *jamais*, *guère*, *nul*, *nullement*, *aucun*, *personne*, *ni*; by *ne* followed by *que*, meaning *only*; and by *ne* followed by *plus*, meaning *no more*:—

L'ambition, seigneur, *n'a guère* de limites. BOURSAULT.	*Ambition, my lord, has scarcely any limits.*
*Nul n'*est heureux, s'il *ne* jouit de sa propre estime. J. J. ROUSSEAU.	*No one is happy, unless he can esteem himself.*
*Personne n'*aime à recevoir de conseils. DE SÉGUR.	*No one likes to receive advice.*
Un méchant *ne* sait *jamais* pardonner. NOËL.	*A wicked man never knows how to forgive.*

With two verbs, the adverbs of negation are placed with the one they are intended to modify:—

Je *ne puis pas* y aller.	I cannot *go there.*
Je puis *ne pas y aller.*	*I may* not go *there.*
Il *n'ose pas* le dire.	*He* does not dare *to say so.*
Il ose *ne pas* le *dire.*	*He is impudent enough* not to say so.

Ne *used idiomatically.*

The negative *ne* is used without any negative sense after the conjunctions **à moins que**, *unless*; **de peur que, de crainte que**, *for fear that*:—

À moins que vous *ne* lui parliez.	*Unless you speak to him.*
*De peur qu'*on *ne* vous trompe. L'ACADÉMIE.	*For fear*, or *lest you might be deceived.*

Ne is used in the same manner after **autre**, *different*; **autrement**, *otherwise*; *plus*, *moins*, *mieux*, forming a comparison, and after the verbs *craindre*, *avoir peur*, *trembler*, *appréhender*, *empêcher*:—

Il est tout *autre* qu'il *n'*était.	*He is very different from what he was.*
Il parle *autrement* qu'il *n'*agit.	*He speaks and acts very differently.*
Il est *plus* modeste qu'il *ne* le paraît.	*He is more modest than he appears.*
Je *crains* presque, je crains, qu'un songe *ne* m'abuse. RACINE.	*I am almost afraid that a dream is deceiving me.*
Vous *avez* bien *peur* que je *ne* change d'avis. MARIVAUX.	*You fear much, lest I may change my mind.*
La pluie *empêcha* qu'on *ne* se promenât dans les jardins. RACINE.	*The rain prevented their taking a walk in the gardens.*

Remark: Ne is not used when the verb of the preceding clause is accompanied by a negative:—

Il *ne parle pas* autrement qu'il agit.	*He does not speak otherwise than he acts.*
Il *n'est pas* plus modeste qu'il le paraît.	*He is not more modest than he appears.*

After *craindre*, *appréhender*, *avoir peur*, *trembler*, we put *pas* after *ne* when we wish for the accomplishment of the action expressed by the second verb:—

Je *crains* qu'il *ne* vienne *pas*.	*I fear that he may not come.*
J'ai *peur* que mon frère *n'*arrive *pas*.	*I am afraid that my brother may not come.*

THE PREPOSITION.

The preposition is an invariable word which expresses the relations of words to each other.

Prepositions consisting of one word, such as *de*, *à*, *pour*, are called simple prepositions; those consisting of several words, such as *vis-à-vis*, are called compound prepositions.

The prepositions which may precede a verb require it to be in the present or past of the infinitive, except *en*, however, which requires the verb following it to be in the present participle:—

Il l'a dit *pour* cacher sa faute.	*He said it in order to hide his fault.*
Il s'assit *après* avoir parlé.	*He sat down after having spoken.*
Il lit *en* marchant.	*He reads as he walks (while walking).*

Prepositions are classed according to the relations they express, which are:—

1st. Union.

selon, suivant,	*according to.*	avec,	*with.*
		outre,	*besides*, etc.

2nd. Time.

durant, pendant, etc., *during.*

3rd. Order.

avant,	*before.*	dès,	*as soon.*
après,	*after.*	depuis,	*since*

4th. Cause, Means.

moyennant,	*by means of.*	attendu, vu,	*whereas.*
par,	*by.*		

5th. Aim, End.

envers,	*towards,*	concernant,	*concerning.*
pour,	*for, in order to.*	touchant,	*respecting.*

6th. Place.

autour,	*around.*	entre,	*between.*
chez,	*at the house of.*	près,	*near.*
devant,	*before.*	vers,	*towards.*
derrière,	*behind.*	hors,	*out*, etc.

The prepositions *à*, *de*, *en* express many relations:—

À.

Cause:	arme à feu,	*fire-arm.*
Destination:	verre à vin,	*wine-glass.*
Manner:	s'habiller *à* l'anglaise,	*to dress in English style.*
Matter:	un tableau peint à l'huile,	*a picture painted in oil.*
Place:	aller *à* Londres,	*to go to London.*
	rester *à* Paris,	*to stay in Paris.*
Possession:	ce cheval est *à* mon père,	*this horse is my father's.*
Time:	j'irai vous voir *à* huit heures,	*I will call on you at eight o'clock.*

De.

Cause:	je suis content *de* vous voir,	*I am pleased to see you.*
Matter:	une bague *d'*or,	*a gold ring.*
Place:	j'arrive *de* Paris,	*I come from Paris.*
Possession:	la maison *de* ma tante,	*my aunt's house.*
Time:	elle arriva *de* jour,	*she arrived in the day time.*

En.

Manner:	parler *en* maître,	*to speak as a master.*
Place:	le vaisseau est *en* pleine mer,	*the ship is on the high sea.*
Situation:	elle est *en* vie,	*she is alive.*
Time:	nous étions *en* été,	*we were in the summer.*

The Preposition.—Complement of Simple and Compound Prepositions.

Prepositions may be divided according to their complement into three classes:—

1st. Prepositions governing nouns without the aid of another preposition. They are:—

À, *at* or *to.*
Après, *after.*
À travers, *through.*
Attendu, *on account of.*
Avant, *before.*
Avec, *with.*
Chez, *with, at the house of.*
Concernant, *touching.*
Contre, *against.*
Dans, *in.*
De, *of, from.*
Depuis, *since.*
Derrière, *behind.*
Dès, *from, as soon*
Devant, *before.*
Durant, *during.*
En, *in.*
Entre, *between.*
Envers, *to, towards.*
Excepté, *except.*
Hors, } *except* (see Hors below).
Hormis, }
Joignant, *joining.*
Malgré, *in spite of.*
Moyennant, *by means of.*
Nonobstant, *notwithstanding.*
Outre, *besides.*
Par, *by.*
Parmi, *among, amongst.*
Pendant, *during.*
Pour, *for.*
Sans, *without.*
Sauf, *safe, save.*
Selon, *according to.*
Sous, *under.*
Suivant, *according to.*
Sur, *upon.*
Touchant, *touching.*
Vers, *towards.*
Voici, *here is.*
Voilà, *there is.*
Vu, *considering.*

2nd. Prepositions requiring the preposition *de* after them:—

À cause, *on account.*
À côté, *by the side.*
À couvert, *under cover.*
À fleur, *even with.*
À force, *by dint.*
À l'abri, *under shelter.*
À la faveur, *by means.*
À la mode, *according to the fashion.*
À la réserve, *reserving.*
À l'égard, *with regard.*
À l'exception, *excepting.*
À l'exclusion, *excluding.*
À l'insu, *unknown.*
À l'opposite, *contrary.*
moins, *unless, for less.*
raison, *by reason, at the rate.*
Au dedans, *within.*
Au dehors, *without.*
Au delà, *that way, beyond.*
Au-dessous, *under.*
Au-dessus, *above.*
Au-devant, *before, to meet.*
Au lieu, *instead.*
Au milieu, *in the middle.*
Au moyen, *by means.*
Au niveau, *on a level.*
Au péril, *at the peril.*
Auprès, *near.*
Au prix, *at the price.*
Au rez, *on a level.*
Au risque, *at the risk.*
Autour, *around.*
Au travers, *through.*
Aux dépens, *at the expense.*
Aux environs, *in the neighbourhood.*
En deçà, *this way.*
En dedans, *this side, inside.*
En dépit, *in spite of.*
Faute, *for want.*
Hors, *out of.*
Le long, *along.*
Loin, *far.*
Près, *near.*
Proche, *near.*
Vis-à-vis, *opposite.*

3rd. The prepositions followed by *à* are:—

Attenant, *joining.*
Jusque, *as far as.*
Par rapport, *with regard.*
Quant, *as to.*

Remark on the Government of Prepositions.

The rules which we have given with regard to the government of verbs and adjectives apply also to prepositions. When two prepositions require the same complement, it is useless to repeat this complement after each one, but if they require a different complement, it is necessary to give each the proper one. It would, therefore, be incorrect to say, **Un magistrat doit toujours juger suivant et conformément aux lois,** *A magistrate should always judge in accordance with, and conformably to, the laws;* because the preposition *suivant* does not require another preposition, and the adverb *conformément* requires to be followed by the preposition *à*. We must, therefore, say:—

Un magistrat doit toujours juger *suivant* les lois, et *conformément à* ce qu'elles prescrivent. MARMONTEL.	*A magistrate should always judge in accordance with the laws and conformably to what they prescribe.*

Repetition of Prepositions.

The prepositions *à*, *de*, *en*, and *sans*, must be repeated before every complement, be it a noun, a pronoun, or a verb:—

Ce monde-ci n'est qu'une loterie *de* biens, *de* rangs, *de* dignités, *de* droits. VOLTAIRE.	*This world is but a lottery of goods, of ranks, of dignities, of rights.*
L'éloquence est un art très-sérieux, destiné *à* instruire, *à* réprimer les passions, *à* corriger les mœurs, *à* soutenir les lois, etc. FÉNELON.	*Eloquence is a very important art, destined to instruct, to repress passions, to correct manners, to support the laws, etc.*
Telle est la multitude, et *sans* frein et *sans* lois. LA HARPE.	*Such is the multitude, without restraint and without laws.*

The English usage varies considerably. In the first example given we should probably omit all but the first *of*, connecting *dignities* and *rights* with an *and*. In the second example we should repeat the preposition; in the third, if emphasis were required, *without* would be repeated. Otherwise the second preposition would be omitted, and *or* substituted for *and*.

The other prepositions must also be repeated before every noun, pronoun, or verb, unless the words used as complements have a similarity of meaning, in which case the prepositions may be

placed before the first complement only, or before all, at the option of the speaker :—

Je vous donne ceci *pour* vous et *pour* votre frère.	*I give you this for you and for your brother.*
Il perd sa jeunesse *dans* la mollesse et (*dans*) la volupté.	*He wastes his youth in effeminacy and voluptuousness.*

Observations on Several Prepositions.

Avant marks a priority of time and place ; *devant* means simply *opposite, in front of* :—

Je marche *avant* vous.	*I walk before you, i.e., I walk earlier than you, or I have the precedence of you in walking*
Je marche *devant* vous.	*I walk in front of you.*

En, à, dans.—The sense of *en* is more indefinite, more extensive than that of *dans*. *En* is generally used before the name of a division of the earth, a kingdom, etc. ; also before nouns taken in a general sense, which do not admit of being qualified by the definite article ; *à* before the name of a town ; and *dans* before a word qualified by an article or a determinative adjective :—

En Europe, *en* France, *à* Paris, *dans* ma chambre.	*In Europe, in France, in Paris, in my room.*
En Amérique ce sont les bisons qui ont une bosse sur le dos. BUFFON.	*In America bisons have a hunch on their back.*
Dans l'Amérique méridionale le bœuf était absolument inconnu. BUFFON.	*In South America the ox was entirely unknown.*

Chez may be rendered in English by *at, in, to the house of, with, among*, etc. :—

Chez votre père ; *chez* vous.	*At your father's ; at your house.*
La condition des comédiens était infâme *chez* les Romains, et honorable *chez* les Grecs. LA BRUYÈRE.	*The condition of comedians was infamous among the Romans, and honourable with the Greeks.*

General Observations on Prepositions.

A verb following a preposition is placed in the present tense of the infinitive mood. To this rule there are three exceptions, *après* requires the past of the infinitive, *pour* may be followed by the present or by the past of the same mood, and *en* requires the present participle.

En arrivant, elle se mit *à pleurer*.	*On arriving she began to weep.*
Il riait tout *en* me *parlant*.	*He was laughing while speaking to me*
Après avoir parlé, il sortit.	*After having spoken, he went out.*
Elle sortit *après avoir diné*.	*She went out after having dined.*
Sans savoir ce qu'il faisait . . .	*Without knowing what he was doing. . .*
Je l'ai fait *pour* vous *plaire*.	*I have done it in order to please you.*
On le chassa *pour avoir menti*.	*They expelled him for having told a lie.*
Nous venions *d'arriver*.	*We had just arrived.*
Ils sont *à travailler*.	*They are working.*

In French a preposition must always precede its complement : *What are you speaking of ? Whom is he speaking to ?* cannot be translated into French in this order ; the preposition must be put in French before *what* and *whom* :—

De quoi parlez-vous ?	*Of what are you speaking ?*
À qui parlez-vous ?	*To whom are you speaking ?*

Prepositions are used between verbs having the same subject ; conjunctions between verbs having different subjects :—

Je l'ai fait *pour* vous *plaire*.	*I have done it in order to please you, i.e., in order that I might please you.*
Je l'ai dit *pour qu'il* le sache.	*I have said it in order that he should know it.*

When a conjunction is used between two verbs having the same subject, the preposition *de* is added to it :—

Ils s'avancèrent *afin de* mieux voir.	*They advanced in order to see better.*

When a preposition is used between two verbs having different subjects *que* is added to it :—

Je l'ai fait *avant qu'ils* arrivassent.	*I have done it before they arrived.*

The Conjunction.

The conjunction is an invariable word which serves to connect words, clauses, and sentences.

The conjunction is used for this purpose, especially when the clauses it connects have different subjects, a preposition being employed when such clauses have the same subject :—

Je le dis *afin que* vous le sachiez.	*I say it that you may know it.*
Il l'a fait *pour* vous plaire.	*He has done it in order to please you.*

Conjunctions consisting of one word, such as *et, que, car*, etc., are called simple conjunctions ; those consisting of several words, as *c'est-à-dire, pour que, afin que*, etc. are called compound conjunctions.

French conjunctions are classed, as English ones, according to the manner in which they affect the sentence, and therefore this point needs not to be mentioned here.

The principal conjunctions are :—

Afin de, *in order to.*
Afin que, *in order that.*
Ainsi, *thus, so.*
A moins que, *unless.*
Au reste, *besides.*
Aussi, *also, as, too.*
Car, *for, as*
Cependant, *yet, however.*
C'est-à-dire, *that is to say, i.e.*
Comme, *as, like.*
D'ailleurs, *besides, moreover.*
De plus, *moreover.*
De sort que, *so that.*
Donc, *then.*
Et, *and.*
Jusqu'à ce que, *until.*
Lorsque, *when.*
Mais, *but*
Néanmoins, *yet, still, nevertheless.*
Ni, *neither, nor.*
Or, *now.*
Ou, *or.*
Ou bien, *or else.*
Parce que, *because.*
Pendant que, *whilst.*
Pourtant, *yet, however.*
Pourvu que, *providing that.*
Puisque, *since.*
Quand, Quand même, Quoique. — *even, even if ; though, even though ; although.*
Que, *that, in order that.*
Savoir, *to wit, namely, viz., i.e.*
Si, *if, whether.*
Sinon, *if not.*
Soit, *whether.*

Government of Conjunctions.

Conjunctions govern the verbs following them in the indicative, in the conditional, or in the subjunctive mood :—

Il est sûr *que* je *l'ai dit, car* il *m'a entendu.*	*He is sure I have said it, for he has heard me.*
Il fut décidé *qu'il partirait.*	*It was decided that he should start.*
Quoique vous le *sachiez.*	*Although you know it.*

A conjunction cannot govern the infinitive; when, therefore, a conjunction must be used between two verbs having the same subject, *de* is added to it :—

Il vint ici de peur *d'être vu.*	*He came here, lest he might be seen.*

The following conjunctions always require the subjunctive after them in French, whatever mood they may take in English. Those marked with an asterisk require *ne* before the verb :—

Afin que, *in order that.*	Malgré que,†, *although, in spite of.*
*À moins que, *unless.*	Nonobstant que, *notwithstanding.*
Au cas que, *if.*	Non que, *not that.*
Avant que, *before that.*	Non pas que, *not that.*
Bien que, *although.*	Posé que, *supposing that.*
*De crainte que, *for fear.*	Pour que, *that, in order that.*
De peur que, *lest.*	Pourvu que, *provided that.*
En cas que, *in case.*	Quoique, *although, though.*
Encore que, *although.*	Sans que, *without that.*
Jusqu'à ce que, *till, until that.*	Soit que, *whether.*
Loin que, *far from, not that.*	Supposé que, *suppose that.*

Quoique à peine à mes maux je *puisse* resister.	*Although I can scarcely bear my misfortunes,*
J'aime mieux les souffrir, que de les mériter. RACINE.	*I would rather suffer under them than deserve them.*
En cas que vous *persistiez,* il faudra que j'allègue au prince et au roi même votre mauvaise santé. FÉNELON.	*In case you persist, I must mention your bad health to the prince and even to the king.*

The following conjunctions :—**De manière que, de sorte que, en sorte que,** *so that ;* **tellement que,** *in such a manner that ;* **si ce n'est que, sinon que,** *unless that, but that ;* govern the following verb in the indicative or conditional mood, when the preceding verb expresses a positive assertion; but they govern the subjunctive when the preceding verb expresses a desire or a command :—

Il se conduisit très mal, *de sorte qu'il fut* contraint de se retirer.	*He behaved very ill, so that he was obliged to withdraw.*
Faites *en* sorte *qu'on soit* content de vous.	*Behave in such a manner that people may be pleased with you.*

When there are in a sentence two or more verbs governed by a conjunction, *que* must be placed before the second and the following verbs, or the conjunction itself may be repeated :—

Puisqu'on plaide, qu'on meurt, et qu'on devient malade, Il faut des médecins, il faut des avocats. LA FONTAINE.	*Since we plead, die, and become sick, we must have physicians, we must have lawyers.*
Si vous *parlez* et *que* vous *voulez* me prendre avec vous. BESCHERELLE.	*If you go and wish to take me with you.*

The other conjunctions generally govern the same mood in French as in English :—

† Only used with the verb **avoir: malgré qu'il en ait,** *in spite of himself.*

Fais du bien aujourd'hui *puisque* tu *vis* encore. VILLEFRÉ.	*Do good to-day, since thou yet livest.*
Rien n'éblouit les grandes âmes, *parce que* rien n'est plus haut qu'elles. MASSILLON.	*Nothing dazzles great minds, because nothing is higher than they.*

THE INTERJECTION.

An interjection is a word which expresses some feeling or wish.

French interjections are somewhat similar to English ones, and are used in the same manner; and it should be mentioned here that a few French nouns and verbs are used as interjections.

The principal French interjections are the following :—

Ah ! *ah !*	Bravo ! *bravo ! hurrah !*
Bon ! *well !*	Gare ! *beware ! mind !*
Aie ! *ay ! dear me !*	Holà ! *hark ! halloo !*
Hélas ! *alas !*	St ! *hist !*
Hé ! *hey ? ha !*	O ! *O !*
Fi ! *fie !* Fi donc ! *fie ! fie !*	Tiens ! *hold ! look here !*
Oh ! *ho !*	Paix ! *silence ! peace !*
Zest ! *pshaw !*	Courage ! *cheer up !*
Bah ! *Nonsense !*	Tout beau ! *gently !*
Chut ! *hush !*	Morbleu ! Parbleu ! Corbleu ! *zounds !*
Ça ! oh ça ! Allons ! *now ! now then ! come !*	

THE NOUN—ITS PLACE.

We shall now give you some further lessons on the more complex parts of speech, such as the noun, article, verb, adjective, and pronoun. These words all present difficulties, and we have thought it better to reserve until now some of the more puzzling of the rules of French grammar.

In French, as well as in English, a noun used as the subject or nominative of an affirmative or negative sentence generally precedes the verb :—

L'homme le plus obscur aime la liberté. CHATEAUBRIAND.	*The most humble man loves liberty.*
L'espérance tient lieu des biens qu'elle promet. LA CHAUSSÉE.	*Hope takes the place of the benefits which it promises.*

In poetry and in elevated prose, and generally in clauses introduced by a relative pronoun, the subject is sometimes placed after the verb :—

Il n'est point de noblesse où manque la *vertu.* CRÉBILLON.	*Nothing noble can exist where virtue is wanting.*
La fortune est à craindre où manque la *sagesse.* BOURSAULT.	*Where wisdom is wanting, fortune is to be feared.*
La maison *qu'a* achetée votre *père* est belle.	*The house which your father has bought is beautiful.*

In sentences in which the principal clause assumes the form and place of a parenthetic clause, the subject of the principal clause, in French, must follow the verb :—

Heureux, *disait Mentor,* le peuple qui est conduit par un roi sage. FÉNELON.	*Happy, said Mentor, the people who are governed by a wise king.*

NOTE.—The student will notice that if the sentence were introduced by its principal clause,

the subject of the latter could not be inverted, and the sentence would run thus:—

Mentor disait: heureux le peuple qui est conduit par un roi sage.

These two rules are observed also in English.

In interrogative sentences, when the subject is a noun, a possessive, a demonstrative, or an indefinite pronoun (*ce* and *on* excepted), it must be placed before the verb, which must be immediately followed by a pronoun corresponding in gender, number, and person with the subject:—

La *mort* est-*elle* un mal? La *vie* est-*elle* un bien? CRÉBILLON.	*Is death an evil? Is life a benefit?*
Cela est-*il* pour votre frère?	*Is that for your brother?*
Celle-ci est-*elle* à vous?	*Is this one yours?*
Mon père est parti hier; *le vôtre* est-*il* parti avec lui?	*My father started yesterday; did yours go with him?*

When the sentence commences with one of the following words, où, *where;* que, *what;* combien, *how much;* quand, *when;* the noun may be placed immediately after the verb, or in accordance with the rule above:—

Où est votre *père?* Où votre *père* est-*il?*	*Where is your father?*
Mais que sert *un long règne*, à moins qu'il ne soit beau? BOURSAULT.	*Of what use is a long reign, unless it be glorious?*

The noun, used as direct object, has the same place in the sentence in French as in English:—

La force fonde, étend, et maintient un *empire*. SAURIN.	*Power founds, extends, and maintains an empire.*

When there are, in the same sentence, two nouns, one used as direct, the other as indirect object, and those nouns, with the words qualifying or modifying them, are of equal length, the direct object should precede the indirect*:—

Le malheur ajoute *un nouveau lustre à la gloire des grands hommes.* FÉNELON.	*Misfortunes add a new lustre to the glory of great men.*
Avez-vous donné *les livres à mon frère?* GIRAULT DUVIVIER.	*Have you given the books to my brother?*

When, however, the qualifying or explanatory words render the direct object longer than the indirect, the indirect object is placed first:—

Avez-vous donné *à mon frère les livres* que vous lui aviez promis?	*Have you given my brother the books which you had promised him?*
Les hypocrites parent *des dehors* de la vertu *les vices les plus honteux.* NOEL.	*Hypocrites adorn with the appearance of virtue the most shameful vices.*

The indirect object precedes the direct object when the meaning would otherwise be doubtful:—

Tâchez de ramener *par la douceur* ces *esprits égarés.* BESCHERELLE.	*Try to bring back, by mildness, these erring spirits.*

Any other construction would render the sentence equivocal.

In English the name of the possessor frequently precedes the name of the object possessed; and the two are connected by means of 's (the old Saxon genitive termination). In French the order is always different. The name of the object possessed precedes that of the possessor, and the connecting link is a preposition:—

Les livres de mon ami.	*My friend's books.*
Vous avez vu la montre de ma sœur.	*You have seen my sister's watch.*

The name of an object always precedes the name of the substance of which it is formed, or which it contains. The preposition *de* comes between them:—

Une table *de* marbre.	*A marble table.*
La France a beaucoup de carrières *de* marbre.	*France has many marble quarries.*
Une bouteille *de* vin.	*A bottle of wine.*

The word representing an individual always precedes that describing his particular occupation, or the merchandise of which he disposes:—

Un *maître* de *danse.*	*A dancing-master.*
Un *maître* de *langues.*	*A teacher of languages.*
Un *marchand* de *drap.*	*A draper, or dealer in cloth.*

The name of a vehicle, boat, mill, etc., always precedes the noun representing the power by which it is impelled, or the purpose to which it is adapted. The connecting preposition is generally *à*:—

Un moulin *à* vent.	*A wind-mill.*
Un moulin *à* papier.	*A paper-mill.*
Des moulins *à* eau.	*Water-mills.*
Un bateau *à* vapeur.	*A steamboat.*
Une voiture *à* deux chevaux.	*A two-horse carriage.*

The name of an object precedes the noun representing its particular produce, use, or appendages, etc.; the preposition *à* generally connects these nouns:—

Le goût du fruit de *l'arbre à pain* ressemble à celui de l'artichaut. BERNARDIN DE ST. PIERRE.	*The taste of the fruit of the bread tree resembles that of the artichoke.*
Le nom de vertu, dans la bouche de certaines personnes, fait tressaillir comme le grelot du *serpent à sonnettes.* MME. NECKER.	*The name of virtue in the mouth of certain persons makes one shudder like the noise of the rattlesnake.*
Les *bêtes à cornes* ne sont pas si nombreuses que les *bêtes à laine.*	*Horned animals (neat cattle) are not so numerous as sheep (wool animals).*
La *salle à manger.*	*The dining-room.*
Du *bois à brûler.*	*Fire-wood.*
Un *verre à vin.*	*A wine-glass, i.e., a glass for wine.*

THE ARTICLE.—USE OF THE ARTICLE.

The article must be used in French before every noun employed in a general sense, or denoting a whole species of objects; although in similar cases the article is not used in English:—

Les bienfaits peuvent tout sur une âme bien née. VOLTAIRE.	*Benefits are all-powerful with a well disposed mind.*
*L'*honneur, aux grand cœurs, est plus cher que *la* vie. CORNEILLE.	*Honour is with magnanimous hearts more precious than life.*
La honte suit toujours un lâche désespoir. CRÉBILLON.	*Shame always follows a cowardly despair.*

* This must also be the case when the direct is shorter than the indirect object.

The article is used in French, as in English, before a noun denoting a particular object, or taken in a particular sense:—

Le bonheur des méchants comme un torrent s'écoule. RACINE.	*The happiness of the wicked runs away like a torrent.*
L'arbrisseau le plus sain a besoin de culture. FABRE D'ÉGLANTINE.	*The healthiest shrub needs cultivation.*
Le moment du péril est celui du courage. LA HARPE.	*The time of peril is the time for courage.*

The article is used before the names of countries, provinces, seas, rivers, winds, and mountains:—

La France est bornée au midi par *les* Pyrénées et *la* Méditerranée; à l'est par l'Allemagne, *la* Suisse, et l'Italie; au nord par *la* Manche et *la* Belgique, et à l'ouest par l'Océan. Ses principales rivières sont *la* Seine, *la* Loire, *la* Garonne, et *le* Rhône.	*France is bounded on the south by the Pyrenees and the Mediterranean; on the east by Germany, Switzerland, and Italy; on the north by the English Channel and Belgium, and on the west by the Ocean. Its principal rivers are the Seine, the Loire, the Garonne, and the Rhone.*

Those countries which take their name from their capital, or some other city within their boundaries, take no article:—

Naples est un pays délicieux.	*Naples is a delightful country.*
Venise était un état puissant.	*Venice was a powerful state.*
New York est un état sain.	*New York is a healthy state.*

The French use the article before titles prefixed to names:—

Le général Cavaignac.	*General Cavaignac.*
Le président Bonaparte.	*President Bonaparte.*

The article is also used before the names of dignities, of certain bodies, systems of doctrine, and with other words mentioned below:—

La monarchie,	*monarchy.*
Le parlement,	*parliament.*
Le gouvernement,	*government.*
Le christianisme,	*Christianity.*
*L'*épiscopat,	*episcopacy.*
*À l'*église,	*at church.*
*À l'*école,	*at school.*
Au collége,	*at college.*
Au marché,	*at, to market.*
Au lit,	*in bed.*
etc.	etc.

Before the names of the seasons, and the following expressions:—

*L'*année prochaine,	*next year.*
*L'*année dernière,	*last year.*
Le printemps prochain,	*next spring.*
*L'*automne dernier,	*last autumn.*
La semaine dernière,	*last week.*
etc.	etc.

The names of several cities take the article. Those nouns have generally a meaning, and indicate often natural objects:—

Le Hâvre,	*Havre.*
La Haye,	*The Hague.*
La Rochelle,	*Rochelle.*
Le Détroit,	*Detroit.*

In speaking of the parts of the body or of the qualities of the mind, the French use the article in cases where the English use a possessive adjective or the indefinite article:—

Votre frère a *les* cheveux noirs.	*Your brother has black hair.*
Il s'est blessé à *la* main.	*He has hurt his hand.*
Charles a *la* mémoire excellente.	*Charles has an excellent memory.*

LOGARITHMS.—II.

[*Continued from p.* 236.]

LOGARITHMS OF PRIME NUMBERS.

37. By the application of either of the preceding methods, or by a judicious combination of both, the logarithms of all the prime numbers to any extent may be found. The following table exhibits the logarithms of some prime numbers, which may be calculated in the manner proposed:—

Natural Nos.	Logarithms.	Natural Nos.	Logarithms.
3	·477121	29	1·462398
7	·845098	31	1·491362
11	1·041393	37	1·568202
13	1·113943	41	1·612784
17	1·230449	101	2·004321
19	1·278754	1013	3·005609
23	1·361728	etc.	etc.

38. The logarithms of the powers of a prime number are found by multiplying its logarithm by the indices of those powers (*see* Art. 22). On this principle the following tables are constructed:—

LOGARITHMS OF THE POWERS OF 2.

Log. 4 = 2 × ·301030 = ·602060.
" 8 = 3 × ·301030 = ·903090.
" 16 = 4 × ·301030 = 1·204120.
" 32 = 5 × ·301030 = 1·505150.
" 64 = 6 × ·301030 = 1·806180.
etc. etc. etc.

LOGARITHMS OF THE POWERS OF 3.

Log. 9 = 2 × ·477121 = ·954242.
" 27 = 3 × ·477121 = 1·431364.
" 81 = 4 × ·477121 = 1·908485.
" 243 = 5 × ·477121 = 2·385606.
" 729 = 6 × ·477121 = 2·862728.
etc. etc. etc.

39. The logarithms of the composite numbers are found by the addition of the logarithms of the factors (*see* Art. 19). On this principle the following table is constructed:—

LOGARITHMS OF COMPOSITE NUMBERS.

Log. 6 = log. 2 + log. 3 = ·778151.
" 12 = " 2 + " 6 = 1·079181.
" 18 = " 3 + " 6 = 1·255273, etc.
" 14 = " 2 + " 7 = 1·146128.
" 21 = " 3 + " 7 = 1·322219.
" 28 = " 4 + " 7 = 1·447158, etc.
" 15 = " 3 + " 5 = 1·176091.
" 20 = " 2 + " 10 = 1·301030.
" 25 = " 5 + " 5 = 1·397940, etc.
Log. 105 = log. 3 + log. 5 + log. 7 = 2·021189.
" 385 = " 5 + " 7 + " 11 = 2·585461.
" 1001 = " 7 + " 11 + " 13 = 3·000434, etc.

40. The integer prefixed to the decimal part of a logarithm is called its *index* or *characteristic*. Thus, in the preceding table, the logarithm of 20 is 1·301030, of which 1 is the index or characteristic, and ·301030 is the decimal part or mantissa.

41. From the skeleton tables and the preceding articles, it is evident (1) that the index of the

logarithm of every number between 0 and 10 is 0; the index of the logarithm of every number between 10 and 100 is 1; the index of the logarithm of every number between 100 and 1000 is 2; and so on. Hence, generally, *the index of the logarithm of every integer is a number less by unity than the number of figures which it contains.* The index of the logarithm of a mixed number, being determined solely by its number of figures, is, of course, not affected by the decimal.

42. (2) The index of the logarithm of every decimal of which the highest place is tenths is -1; the index of the logarithm of every decimal of which the highest place is hundredths is -2; thousandths, -3; and so on. Hence, generally, *the index of the logarithm of every decimal is a number denoting its highest place, with a negative sign attached to it.* The use of this sign, which is usually written *above* the index, is to indicate that when the logarithm of a decimal is added, its index is to be subtracted, and when the logarithm of a decimal is subtracted, its index is to be added.

43. In tables of logarithms, only the decimal parts or mantissæ of the logarithms of the natural numbers are printed; hence, the preceding rules for supplying their indices are indispensably necessary for the purpose of calculation. To facilitate this process, however, the following table is added:—

TABLE OF INDICES OF LOGARITHMS.

Part I.

For Integers.	Indices.	For Integers.	Indices.
Units	0	Tens of Millions	7
Tens	1	Hundreds of Millions	8
Hundreds	2	Thousands of Millions	9
Thousands	3	Tens of Thousands of Millions	10
Tens of Thousands	4	Hundreds of Thousands of Millions	11
Hundreds of Thousands	5	etc.	etc.
Millions	6		

Part II.

For Decimals.	Indices.	For Decimals.	Indices.
Tenths	$\bar{1}$	Hundredths of Millionths	$\bar{8}$
Hundredths	$\bar{2}$	Thousandths of Millionths	$\bar{9}$
Thousandths	$\bar{3}$	Tenths of Thousandths of Millionths	$\overline{10}$
Tenths of Thousandths	$\bar{4}$	Hundredths of Thousandths of Millionths	$\overline{11}$
Hundredths of Thousandths	$\bar{5}$	etc.	etc.
Millionths	$\bar{6}$		
Tenths of Millionths	$\bar{7}$		

44. As an additional illustration of the principles on which the indices of logarithms are supplied, the following table is added; it shows the change that takes place in the index of the logarithm of a number by merely lowering its value in the decimal scale of notation:—

Numbers.	Logarithms.	Numbers.	Logarithms.
100200	5·000868	·1002	$\bar{1}$·000868
10020	4·000868	·01002	$\bar{2}$·000868
1002	3·000868	·001002	$\bar{3}$·000868
100·2	2·000868	·0001002	$\bar{4}$·000868
10·02	1·000868	·00001002	$\bar{5}$·000868
1·002	0·000868	etc.	etc.

45. The preceding tables and remarks clearly show the advantages which the common system of logarithms possesses over every other, in consequence of its base being the same as the root of the decimal scale of notation. By merely increasing or diminishing by unity the index of the logarithm of a number, the logarithm of a decimal multiple or sub-multiple of that number is immediately obtained. Hence, the calculation of the logarithm of one number is sufficient for the determination of innumerable others; for, by tabulating the decimal parts of the logarithms of all integers from 1 to 10,000, or from 1 to 100,000, etc., the complete logarithms of such numbers can easily be found, whether they be considered as integers, decimals, or mixed numbers; the proper indices being supplied according to the foregoing rules.

46. A system of logarithms founded on any other base but 10 would want all the advantages above mentioned. The logarithms of all such numbers as are determined by the mere change of the index in the common system would require to be separately calculated and tabulated with their indices. The logarithms of all fractions, as well as integers, and the logarithms of all numbers of which the factors were powers of the base, would require the same operation to be performed. For though, in the latter case, the calculation of the logarithms would be as easy as before, yet their tabulation with indices would still be necessary, as the bare inspection of the numbers themselves would not be sufficient to suggest the proper index as in the common system. The disadvantages would be even more strongly felt in the reverse operation of finding from the tables the number corresponding to any given logarithm.

47. In addition to the decimal parts of the logarithms of the common system, which are given in tables of logarithms, the average differences of every five logarithms are usually given in an adjoining column, for the purpose of rendering it easy to obtain the approximate logarithms of numbers greater than those contained in the table. The approximate logarithms of such numbers are obtained on the principle that the differences of numbers which differ *little* from each other are *nearly* proportional to the differences of their logarithms. Thus in Part I. of the Third Skeleton Table, Art. 32, the successive differences of the numbers 1·00056, 1·00028, and 1·00014, are ·00028 and ·00014; and the differences of their logarithms are ·000122 and ·000061; now, the following proportion is correct, as far as the decimals extend:—

$$\cdot00028 : \cdot00014 :: \cdot000122 : \cdot000061.$$

But were the decimals further extended, this

proportion would be found to be only *nearly* correct. The application of the principle thus established, however, is sufficiently correct for all practical purposes.

TABLES OF LOGARITHMS.

The following tables will be found very useful, not only to students who are endeavouring to make themselves acquainted with logarithms, but also to persons who are desirous of abridging calculations of any description, especially those connected with the mathematical and philosophical sciences. The first table, called *Table of Logarithms*, contains the *mantissæ of the logarithms* of all numbers from 1 to 10,000, according to the *common system*, of which the base is 10. The decimal part of a logarithm is called its *mantissa*, and the integral part is called its *index* or *characteristic*. Thus in the logarithms 0·477121, 1·041393, and 3·005609, the decimal parts ·477121, ·041393, and ·005609 are the mantissæ; and the integral part, 0. 1, and 3, are the indices or characteristics.

The mantissæ of the logarithms in the first table extend only to four decimal places; but these are reckoned sufficient for ordinary purposes. If, however, a greater degree of accuracy be required than can be obtained from this table, recourse must be had to more extensive tables. Let us now proceed to explain our own tables contained in this and the following lesson.

In the first vertical column of the table are contained the first two figures of any given number, whose logarithm is required, within the range above mentioned. In the next ten vertical columns is contained the third figure of any such number; these ten columns are headed *Third Figure*. In the next nine vertical columns is contained the fourth figure of any such number; and these nine columns are headed *Fourth Figure*.

If the logarithm of a number be required which consists of one figure only, as of the *nine digits*, seek for that figure with a cipher annexed to it in the first column of the table; and when it is found, then you will find the mantissa of its logarithm in the same horizontal line in the adjoining column on the right, under the figure marked 0 at the top. To this mantissa prefix the index in the manner described in the preceding lessons, and you will have the required logarithm. Example: Required the logarithm of the number 4. Here, looking for 40 in the first column of the table, you find in the same horizontal line, in the adjoining column on the right, and under 0 at the top, the mantissa ·6021; to this mantissa prefix 0, which is the index for units, and you have 0·6021 for the logarithm of the number 4. If the logarithm of the number 40 were required, the mantissa would be the same, but the index would be 1 and the logarithm 1·6021. If the logarithm of 400 were required, the mantissa would still be the same; but the index would be 2, and the logarithm 2·6021; and so on.

If the logarithm of a number be required which consists of two figures only, as of all numbers between 10 and 99, seek for that number in the first column of the table; and when you have found it, the mantissa of its logarithm you will find in the same horizontal line in the adjoining column on the right, under the figure marked 0 at the top. To this mantissa prefix the index as before, and you will have the complete logarithm. Thus: Required the logarithm of the number 78. Here, looking for 78 in the first column of the table, you find in the same horizontal line, in the adjoining column on the right, and under 0 at the top, the mantissa ·8921; to this mantissa prefix 1, which is the index for tens, or for a number consisting of two integer figures, and you have 1·8921 for the logarithm of the number 78. If the logarithm of the number 7·8 were required, the mantissa would be the same, but the index would be 0, and the logarithm 0·8921. If the logarithm of the number ·78 were required, the mantissa would still be the same; but the index would be $\overline{1}$, and the logarithm $\overline{1}$·8921; and so on.

If the logarithm of a number be required which consists of three figures, as of all numbers between 100 and 999, seek for the first two figures of the number as in the preceding case—that is, in the first column of the table; and when these are found, you will then find the mantissa of its logarithm in the same horizontal line in one of the ten adjoining columns on the right, under the *third figure of the number* at the top. To this prefix the proper index, and you will have the logarithm required. Thus let the logarithm of 476 be required. Here, looking for 47 in the first column of the table, you find in one of the ten adjoining columns on the right, and under 6 at the top, the mantissa ·6776; to this prefix 2, which is the index for hundreds, or for a number consisting of three integer figures, and you have 2·6776 for the logarithm of the number 476. If the logarithms of the numbers 47·6, 4·76, ·476, or ·0476 were required, the operation for finding the mantissa of each would be the same, and they would be, on the principles now fully explained to our students, 1·6776, 0·6776, $\overline{1}$·6776, and $\overline{2}$·6776 respectively.

If the logarithm of a number be required which consists of four figures, as of all numbers between 1000 and 9999, seek for the mantissa corresponding to the first three figures, as in the preceding case, and in the same horizontal line in one of the nine columns, headed *Fourth Figure*, you will find,

under the fourth figure at the top, a number which is *to be added* to the mantissa in order to make it the complete mantissa required; to this prefix the index as before, and you will have the logarithm sought. For example, let it be required to find the logarithm of the number 5768. Here, looking for the mantissa of the first three figures, 576, as in the preceding case, you find ·7604; and in the same horizontal line with it, under the *fourth figure*, 8, you find the number 6, which is to be added to ·7604; this being done, you have ·7610 for the complete mantissa; prefixing the index 3, according to previous directions, you have 3·7610 for the complete logarithm required. If the logarithms 57680, 576·8, 5·768, or ·005768 were required, the operation of finding the mantissa would still be the same; but the indices, according to the previous rules, would be different, the logarithms being respectively 4·7610, 2·7610, 0·7610 and $\bar{3}$·7610.

TABLE OF LOGARITHMS.

	THIRD FIGURE.										FOURTH FIGURE.								
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4	8	12	17	21	25	29	33	37
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	11	15	19	23	26	30	34
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3	7	10	14	17	21	24	28	31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3	6	10	13	16	19	23	26	29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3	6	9	12	15	18	21	24	27
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3	6	8	11	14	17	20	22	25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3	5	8	11	13	16	18	21	24
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2	5	7	10	12	15	17	20	22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2	5	7	9	12	14	16	19	21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2	4	7	9	11	13	16	18	20
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2	4	6	8	11	13	15	17	19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2	4	6	8	10	12	14	16	18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2	4	6	8	10	12	14	15	17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1	2	3	4	5	6	7	8	9
45	6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	4	4	5	6	7	8
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	2	3	4	5	6	7	7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1	2	2	3	4	5	6	6	7
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1	2	2	3	4	5	5	6	7
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	1	2	2	3	4	5	5	6	7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1	2	2	3	4	5	5	6	7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1	1	2	3	4	4	5	6	7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1	1	2	3	4	4	5	6	7

TABLE OF LOGARITHMS (*continued*).

	THIRD FIGURE.										FOURTH FIGURE.								
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	1	1	2	3	4	4	5	6	6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1	1	2	3	4	4	5	6	6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1	1	2	3	3	4	5	6	6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1	1	2	3	3	4	5	5	6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1	1	2	3	3	4	5	5	6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1	1	2	3	3	4	5	5	6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1	1	2	3	3	4	5	5	6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	1	2	3	3	4	5	5	6
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1	1	2	3	3	4	4	5	6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	1	1	2	2	3	4	4	5	6
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1	1	2	2	3	4	4	5	6
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	1	1	2	2	3	4	4	5	5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1	1	2	2	3	4	4	5	5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	1	1	2	2	3	4	4	5	5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1	1	2	2	3	4	4	5	5
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	1	1	2	2	3	3	4	5	5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	1	1	2	2	3	3	4	5	5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	1	1	2	2	3	3	4	4	5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1	1	2	2	3	3	4	4	5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1	1	2	2	3	3	4	4	5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1	1	2	2	3	3	4	4	5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	1	1	2	2	3	3	4	4	5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	1	1	2	2	3	3	4	4	5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	1	1	2	2	3	3	4	4	5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	1	1	2	2	3	3	4	4	5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	1	1	2	2	3	3	4	4	5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1	1	2	2	3	3	4	4	5
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	0	1	1	2	2	3	3	4	4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	0	1	1	2	2	3	3	4	4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0	1	1	2	2	3	3	4	4
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	0	1	1	2	2	3	3	4	4
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	0	1	1	2	2	3	3	4	4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	0	1	1	2	2	3	3	4	4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	0	1	1	2	2	3	3	4	4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	0	1	1	2	2	3	3	4	4
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	0	1	1	2	2	3	3	4	4
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	0	1	1	2	2	3	3	4	4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0	1	1	2	2	3	3	4	4
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	0	1	1	2	2	3	3	4	4
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	0	1	1	2	2	3	3	3	4

ENGLISH.—XXIX.

[*Continued from p. 249.*]

PREPOSITIONS.

THE preposition is intimately connected with two other parts of speech, the verb and the noun. The relation of the verb to its object, or of the doer and the doing to the thing done, is often expressed but imperfectly by the verb. Thus, when we say *I go*, we make a merely general statement; if we wish to give specific information, we say—

I go *from* the city *into* the country.

It is not every object, however, which requires a preposition. When we say—

I pull the boat,

boat stands in immediate dependence on *pull*, and neither has nor needs any preposition; but if we add a second object to that object, we (for the most part) employ a preposition; as—

I pull the boat *from* the shore.

The verb and preposition may indeed be regarded as one word—thus, *to come-from*, *to go-to*—when by

means of the several suffixes a modification of meaning is in each instance caused. These intransitive verbs thus supplemented become transitive—that is, have an immediate object, for we can say—

I come-from Bath; I go-to Bath, etc.

The preposition is thus seen to stand between the verb and its *object* in *order* to assist the *former* in the expression of the latter. As, however, the object stands in immediate dependence on the preposition, and only in remote dependence on the verb, so we may frame the rule thus:—

A noun as an object may be dependent on a preposition; or thus:—

A preposition may govern a noun as its object: as—

"Ah! who can tell the triumphs *of* the mind,
By truth illumined, and *by* taste refined?"—*Rogers.*

We have already seen that an infinitive mood may be the object of a verb in the finite mood: as—

I love *to wander,*

where *wander* is an infinitive governed by *I love.* Now, instead of *to wander* you may supply a noun and say—

I love *wandering,* or I love *a stroll.*

The preposition *to,* you thus see, connects its object with a transitive verb, when that object is a verb. The preposition in such cases is a connecting word, but a connecting word which is essential to the import. That it is essential you may learn by removing it; thus, *I love wander.* Here, too, the object *wander* is in immediate dependence on *to,* and only in remote dependence on *I love;* consequently, we may say that

The latter of two verbs connected together by the preposition TO *is dependent on, or governed by, that preposition.*

We may also lay it down as a fact that

The preposition TO *stands before a verb when it is used in its most general application, or in the infinitive mood.*

Now a verb so used is in meaning very near to the noun. It is, indeed, a verbal noun: as—

To learn to die is the great business of life.

Usage allows the preposition *to,* thus employed, to be in one kind of sentence strengthened by another preposition, namely, *for,* which, however, has its own object: as—

"For us to learn to die is the great business of life."

The preposition *for* thus set at the beginning, followed by an infinitive, forms a clause or member which is the subject of the finite verb.

As prepositions govern nouns, so may they govern whatever stands as, or is used with, the force of a noun, and consequently prepositions may govern (1) *A present participle used as a noun;* as, "He accused the boys of *fighting.*" (2) *A present participle and a noun:* as, "He accused the soldiers of *being cowards.*" (3) *A present combined with a past participle:* as, "He accused the soldiers of *having been cowards.*" (4) *A clause of a sentence or a phrase:* as, "He accused the troops of *having acted in a cowardly manner.*"

Prepositions in general stand before the nouns they govern, but by poetic licence they may be placed after: as—

"Wild Carron's lonely *woods among.*"—*Langhorne.*

In verbs used with separable prepositions, the preposition, when separated, may stand after its object, and even at the end of the sentence:—

"This you pride yourself *upon* and *this* you are ruined *by.*"

In some phrases the preposition follows the noun: as—

"Civil and religious liberty *all the world over.*"

Like, near, next, and other adjectives and adverbs, are used with an object immediately dependent on them:—

"And earthly power doth then show *likest God's*
When mercy seasons justice."—*Shakspeare.*

Care must be taken not to confound prepositions with adverbs, especially with regard to the words which are used both ways. *Before* is an instance: as—

Adverb. She entered before. *Preposition.* She entered before me.

You may ascertain whether in any particular case *before* (and similar words) is an adverb or preposition by considering what it goes with, a verb or a noun: as—

The king came near. The king came near *the city.*

In the first place, *near* does no more than qualify *came;* in the second, *near* governs *the city.*

The prepositions *between* and *among* have specific meanings, and should be used accordingly. *Between* (twain, *two*) is *by two,* that is, two individuals, or two sets, or classes of individuals. *Among* denotes distribution to several:—

He divided the apple *between* his *brother* and *sister.*
He divided the apples *among the children.*

Among differs from *in* in this, that while *among* denotes distribution, *in* denotes presence in a place, and so requires its object to be *one,* one individually, or one collectively: as—

In a great nation many are found *among* whom charity may find deserving objects.

CONJUNCTIONS.

Joining is the office of conjunctions. The joining may take place between two words, between two clauses, and between two propositions. Properly

the conjunction *and* joins two things—*this* with *that*—and is in consequence required before every second noun, adjective, verb, etc. The practice of putting *and* before only the last word of a series is of modern date. As an illustration of the merely uniting functions of the conjunction, take this example:—

1st Clause. 1
"Let there be no strife, I pray thee, between me *and* thee,
2 3 *2nd Clause.*
and between my herdmen *and* thy herdmen, *for* we are brethren." (Gen. xiii. 8.)

The conjunction *and*, No. 1, unites the pair of words, *me, thee*; No. 2 unites the first clause with the second; the third *and* unites "my herdmen" with "thy herdmen."

Conjunctions unite words which bear to each other the same grammatical relation.

This rule is commonly stated thus: Conjunctions connect the like tenses of verbs and the like cases of nouns. The readiest syntactical guide in the use of conjunctions is the thought. We will take two instances, one of concord, the other of dependence:—

Concord. You and I are ill. *Dependence.* He beat you and me.

In the first proposition, we have *I* after *and*, not so much because *you* is in the nominative case, as because the statement is that I am ill. This appears by analysis—

You are ill. I am ill.

In the second proposition, *me* occurs after *and*, because *me*, as well as *you*, is dependent on *beat*: as—

He beat *you*. He beat *me*.

which is shortened into

He beat you and me.

Aided by these observations, you will have no difficulty in determining what form your words should assume when united by conjunctions. You will, for instance, see that of these two propositions the first is erroneous, and the second correct:—

1. He is wiser than me.
2. He is wiser than I (am).

So with

a *b* *c*
You love him better than I (are).
You love him better than *me* (I).

These sentences are right or wrong according to the meaning you intend. If you mean that *a* loves *b* better than *c* loves *b*, the first is correct; in full, the sentence would then stand:

You love him better than I love him;

but if you mean that *a* loves *b* better than *a* loves *c*, then the sentence is incorrect, as may appear thus:—

You love him better than you love me.

The conjunction *as* carries with it the force of a relative pronoun, that is to say, it introduces a second proposition to which it serves for the subject: as—

"But as many *as* received him." (John i. 12.)

The employment of the conjunction *that*, as in

They affirmed (*that*) he would not come,

is required as indispensable by some grammatical critics with an emphasis which may be somewhat undue. That the sense does not require its insertion is obvious from its nature and from the sentence just given as an example. If, however, the second member of the sentence is separated from the first by several intervening words, *that* may serve as a point on which the mind may rest, until it takes up the clause to which it refers, and for which in some sort it is a substitute: as—

Your brother stated that, as he and your cousin were passing down High Street, they saw a child fall from the roof of a house.

CORRESPONDING CONJUNCTIONS.

Certain conjunctions go in pairs; that is, the precedence of the one necessitates the use of the other, for example:—

1. *Though—yet*; as, "*Though* he die, *yet* shall he live." (John xi. 25.)

2. *Whether—or*; as, "*Whether* it be greater or less."—*Butler.*

3. *Either—or*; as, "The indulgence of a declamatory manner is not favourable *either* to good composition *or* good delivery."—*Blair.*

4. *Neither—nor*; as, "John the Baptist came *neither* eating bread *nor* drinking wine." (Luke vii. 33.)

5. *Both—and*; as, "I am debtor *both* to the Greeks *and* to the barbarians, *both* to the wise *and* to the unwise." (Rom i. 14.)

6. *Such—as*; as, "An assembly *such as* earth never saw."—*Cowper.*

7. *Such—that*; as, "The difference is *such that* all will perceive it."

8. *As—as*; as, "And he went out from his presence a leper *as* white *as* snow." (2 Kings v. 27.)

9. *As—so*; as, "*As* two are to four, *so* are six to twelve."

10. *So—as*; as, (1) "How can you descend to a thing *so* base *as* falsehood?" (2) "No lamb was e'er *so* mild *as* he."—*Langhorne.* (3) "We ought to read blank verse *so as* to make every line sensible to the ear."—*Blair.*

11. *So—that*; as, "No man was *so* poor *that* he could not make restitution."—*Milman.*

12. *Not only* or *not merely—but, but also, but even*; as, "In heroic times smuggling and piracy were deemed *not only* not infamous, *but even* absolutely honourable."—*Maunder's Grammar.* "These are questions *not* of prudence *merely*, *but* of morals *also*."—*Dymond's Essays.*

INTERJECTIONS.

Instead of speaking *of* a person, you may speak *to* a person, or call *upon* a person; you may employ the style of direct address. For such kinds of address our nouns in English have no specific form; but exclamations or interjections supply the place of such forms, and mark the existence of a direct address or appeal. That address or appeal may

have various meanings, and even various shades of meaning, corresponding with the state of the feelings at the moment: as—

> "*Ah* Dennis! Gildon *ah!* what ill-starr'd rage
> Divides a friendship long confirm'd by age!"—*Pope.*
> "Alas! poor Yorick."—*Shakespeare.*

Sometimes interjections, for instance, ***O! oh! ah! lo!*** merely call attention, or indicate an appeal or an address; in such cases they are followed by the case of the subject, or that of the object: as—

> *Subject:* "O thou unknown, almighty Cause!"—*Burns.*
> *Object:* "Lo! the lilies of the field,
> How their leaves instruction yield!"—*Heber.*

When deep feeling is intended, the case of the object is used with a pronoun of the first person: as—

> Ah me! oh, unhappy me! woe is me!

that is, ah! what will become of me! oh, what has befallen unhappy me! woe is to me! or, woe is on me!

> "Judas said, Hail, master! and kissed him."
> (Matt. xxvi. 49)
> "Hail, Macbeth!"—*Shakespeare.*

That is, Hail be *to* thee, O master! Hail (health) be *to* Macbeth!

In order to distinguish the subject and the object, when used with exclamations or interjections, from the subject and the object when employed in the third person singular, the former may be called the subject of direct address, and the latter the object of direct address.

The interjection *woe to!* requires the case of the object; the object, in reality, is governed by the preposition *to*:—

> "Woe *to* them that join house to house!" (Isa. v. 8.)

The exclamation ***Oh for!*** signifies, Oh that I possessed! as—

> "Oh for that warning voice!"—*Cowper.*

but ***alas for!*** simply expresses grief towards: as—

> "Alas for Sicily!"—*Milton.*

COMPOUND SENTENCES.

A simple sentence is a sentence which has one subject and one affirmation or predicate; and a compound sentence is a sentence that has more than one subject and more than one predicate. The component parts of a compound sentence are called its members. These members may be two or more; they may also each form a separate sentence:—

COMPOUND SENTENCES OF TWO MEMBERS.

(1) He will perish	(2) who loves unrighteousness.
The lark sang his matins	and sank into his nest.

The first sentence is equivalent to these two positions:—

1. Someone will perish.
2. The lover of unrighteousness will perish.

The second sentence is equivalent to these two statements:—

1. The lark sang his matins.
2. The lark sank into his nest.

COMPOUND SENTENCES OF THREE MEMBERS.

1	2	3
When the Queen arrived,	the fleet had weighed anchor	and sailed.

1. The Queen arrived.
2. Before then the fleet had weighed anchor.
3. Before then the fleet had sailed.

Thus what, in the compound sentence stands as three members, becomes in the analysis three individual sentences.

It is easy to see that the members may be increased almost at pleasure:—

> The sick and all but dying man drinks water and revives.

Compound sentences have members of two kinds, the principal and the accessory. The principal member is that which enunciates the leading thought, the accessary member is that which enunciates the subordinate thought:—

PRINCIPAL MEMBER.		ACCESSARY MEMBER.
The man drinks	(and)	is refreshed.

The accessary member (or members) may be of two kinds—namely, interposed or appended. An accessary member is interposed when it appears in the body of a sentence, being introduced by a relative pronoun, a relative adverb, or a conjunction; for example:—

	PRINCIPAL.	ACCESSARY INTERPOSED.	PRINCIPAL.
Rel. Pron.:	The man	who drinks	is refreshed.
Rel. Adv.:	The man	when he drinks	is refreshed.
Conjunc.:	The man	if he drinks	is refreshed.

Appended members are added by means of conjunctions, adverbs, and pronouns:—

	PRINCIPAL.	ACCESSARY APPENDED.
Conjunc.:	The man drinks	*and* is refreshed.
Adverb:	The man is refreshed	*when* he drinks.

The principal member may be expanded: as—

$$\left.\begin{array}{l}\text{The man drinks}\\ \text{The man eats and drinks}\end{array}\right\}\text{and is refreshed.}$$

The interposed accessary member may also be expanded: as—

$$\text{The man}\left\{\begin{array}{l}\text{who drinks}\\ \text{who eats and drinks}\end{array}\right\}\text{is refreshed.}$$

The appended member, too, may be expanded: as—

$$\text{The man drinks (and)}\left\{\begin{array}{l}\text{is refreshed.}\\ \text{is refreshed and strengthened.}\end{array}\right.$$

Sentences may be further divided into the direct and the inverted. A sentence is direct when the principal member precedes the accessary: as—

PRINCIPAL.		ACCESSARY.
The man drinks	(and)	is refreshed.

A sentence is inverted when the accessary sentence precedes the principal :—

ACCESSARY.	PRINCIPAL.
The man is refreshed	if he drinks. when he drinks. should he drink.

Relative pronouns are such pronouns as relate to some preceding noun, called the antecedent—that is, the foregoing word: for example—

	ANTECEDENT.	RELATIVE.	PREDICATE.
Subject. :	The man	*who* drinks water	is wise.
Object. :	The men	*whom* he met	he struck.

The relative must agree with its antecedent in person, gender, and number: as—

ANTECEDENT.	RELATIVE.	PREDICATE.
1. I	who	read.
2. He	who	reflects.

In the first of these instances, *who* is of the first person, because *I* is of the first person; *who* is of the singular number, because *I* is of the singular number. The effect of the relative on the verb is more clearly seen in the second instance, where an *s* is added to the verb, which accordingly appears as *reflects.*

As a subject for exemplifying the doctrines laid down in regard to the structure of sentences, I shall take a passage from Daniel Defoe, a writer of idiomatic English :—

COMPOUND SENTENCE.

"Oxford makes by much the best outward appearance of any city I have seen, being visible for several miles round on all sides in a most delightful plain; and adorned with the steeples of the several colleges and churches, which make a glorious show."

Here I must premise that the form "the best outward appearance of any city," etc., is incorrect, and should have been "the best outward appearance of all the cities I," etc. This compound sentence may be reduced into these simple sentences :—

1. Oxford makes a very good appearance.
2. Oxford makes an appearance better than many cities.
3. I have never seen a city with a better appearance than Oxford.
4. Oxford is visible for several miles round.
5. Oxford is visible from all sides.
6. Oxford stands in a most delightful plain.
7. Oxford is adorned with the steeples of several colleges.
8. Oxford is adorned with the steeples of several churches.
9. The architectural decorations of Oxford make a glorious show.

The resolution of this long sentence into the several distinct propositions which it contains has, by showing the meaning of the several parts, prepared the way for our exhibiting the logical relations which those parts sustain to each other: thus—

LOGICAL RELATIONS OF THE SENTENCE.

1. *Oxford*	the subject to 2.
2. *makes*	makes together with 3 the predicate to 1.
3. *the best outward appearance*	the object to 2.
4. *of any city*	adverbial object to 2.
5. *that I have seen*	appended accessary to 2.
6. *being visible*	accessary to the subject 1.
7. *for several miles round*	adverbial object to 6.
8. *on all sides*	" "
9. *in a most delightful plain*	" "
10. *and adorned*	second accessary to 1.
11. *with the steeples*, etc.	adverbial object to 10.
12 *which make a glorious show*	appended accessary to 10.

Several of these parts may be analysed or explained: for example—

No. 3 consists of the definite article *the*, the superlative adjective *best*, the adjective *outward* in the positive degree, and the common noun *appearance*, which is the object of the verb *makes*.

No. 6 presents a case of explanatory apposition, since *being visible* is subjoined to the subject *Oxford*, in order to state some additional facts respecting it; No. 10 stands to No. 1 in the same relation.

No. 12 presents an appended relative necessary sentence, of which these are the components—namely, *which*, a relative pronoun agreeing with its antecedent *steeples*; *make*, a verb in the indicative mood, third person, plural number, agreeing with its subject *which*; *a*, the indefinite article limiting *show*; *glorious*, an adjective qualifying *show*; *show*, a common noun dependent on, or the object to, the verb *make*. Viewed structurally, this appendage stands thus :—

SUBJECT.	PREDICATE.		
	Verb.		*Object.*
Which	make	a glorious	show.

By way of applying what you have learnt, take portions of any good prose author, mark the logical relations of the sentences after you have resolved each into the simple propositions of which it consists, and explain by grammatical analysis (that is, "parse") the several components. In other terms, convert each of these compound sentences into simple sentences. Distribute each simple sentence into subject and predicate, distinguishing the verb (the copula) and the attribute. Next, exhibit each compound sentence in its several members, showing what are principal, what accessary, and what appended, what interposed; together with the accessaries to the subjects and objects, and the adverbial objects. Finally, give the grammatical analysis of the whole.

CONCLUSION.

If you have given attention to the English lessons, you have at least laid the foundations of a knowledge of your own tongue. You have learnt how words are formed, and in what connection they are used. You have seen how out of them sentences are built up. Nor, it is to be hoped, are you wholly ignorant of phonetics. You have, indeed, at your

command the raw material of speaking and writing accurately and intelligently. Yet you are only on the threshold of your subject. For the best lesson that you can learn from a treatise on any language is to use your opportunities. It remains for you to read such models of English style as come within your reach, and to listen to the voice and study the elocution of the cultivated men and women it may be your privilege to encounter. Thus and thus only will you gain a practical knowledge of your language. In an age of cheap books the masterpieces of English literature are accessible to all, and we hope that you will realise that the learning of the English language is not an end in itself, but a means of appreciating the works of the great poets and prose-writers who have employed it to express their thoughts.

PLANE TRIGONOMETRY.—II.

[Continued from p. 247.]

SUPPLEMENTAL ANGLES (continued).

V. *Numerical Values of certain Trigonometrical Ratios.*—It was stated in the last lesson (Section II.) that the ratios of certain angles could be worked out geometrically. These angles are 45°, 60° (and therefore 30°, its complement), 18° (and therefore 72°). We select 45°, 60°, and 30° as specimens, and work to five places of decimals:—

$$\text{By (7), } \sin.^2 45^\circ + \cos.^2 45^\circ = 1.$$

But since complement of $45^\circ = 45^\circ$ (for $90^\circ - 45^\circ = 45^\circ$), $\sin. 45^\circ = \cos. 45^\circ$, and $\sin.^2 45^\circ = \cos.^2 45^\circ$.

$$\therefore\ 2 \sin.^2 45^\circ = 1, \text{ and } 2 \cos.^2 45^\circ = 1.$$

$$\therefore\ \sin.^2 45^\circ = \frac{1}{2}, \text{ and } \sin. 45^\circ = \frac{1}{\sqrt{2}} = 0{\cdot}70710.$$

$$\text{Similarly, } \cos. 45^\circ = 0{\cdot}70710.$$

$$\text{By (11), } \tan. 45^\circ = \frac{\sin. 45^\circ}{\cos. 45^\circ} = \frac{0{\cdot}70710}{0{\cdot}70710} = 1.$$

$$\text{And by (10), } \cot an. 45^\circ = 1.$$

$$\text{By (14), } \sec. 45^\circ = \frac{1}{\cos. 45^\circ} = \frac{1}{0{\cdot}70710} = 1{\cdot}41421.$$

$$\text{Whence, also, } \operatorname{cosec.} 45^\circ = 1{\cdot}41421.$$

The above results can be verified by constructing a right-angled triangle, as in Fig. 3, with angle $A =$ angle B ($\because$ of 45° each), where side $a =$ side b, and consequently $\tan. A = \tan. 45^\circ = \frac{a}{b} = 1$, and so on.

Again, draw A B D, an equilateral triangle (Fig. 5), with the perpendicular B C.

Then $A = 60^\circ$ and $A B C = 30^\circ$. Also $A C = \frac{1}{2} A D = \frac{1}{2} A B$.

$$\cos. A = \frac{A C}{A B} = \frac{1}{2}, \therefore \cos. 60^\circ = \frac{1}{2} = 0{\cdot}5.$$

$$\text{By (16), } \sin. 60^\circ = \sqrt{1 - \cos.^2 60^\circ} = \sqrt{1 - \frac{1}{4}} = \sqrt{\frac{3}{4}} = \frac{\sqrt{3}}{2} = 0{\cdot}86602.$$

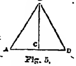


Fig. 5.

$$\text{By (11), } \tan. 60^\circ = \frac{\sin. 60^\circ}{\cos. 60^\circ} = \frac{\frac{\sqrt{3}}{2}}{\frac{1}{2}} = \sqrt{3} = 1{\cdot}73205.$$

$$\text{Similarly, by (12), } \cot. 60^\circ = \frac{1}{1{\cdot}73205} = 0{\cdot}57735.$$

$$\text{By (14), } \sec\ 60^\circ = \frac{1}{\frac{1}{2}} = 2.$$

$$\text{By (15), } \operatorname{cosec}\ 60^\circ = \frac{1}{0{\cdot}86602} = 1{\cdot}15470.$$

As we know the ratios of 60°, we of course know the ratios of 30°, its complement.

VI. *Supplemental Angles.*—The supplement of an angle (less than two right angles) is the angle wanting to complete it to two right angles, or 180°. Thus the supplement of $30^\circ = 180^\circ - 30^\circ = 150^\circ$; supplement of $175^\circ = 180^\circ - 175^\circ = 5^\circ$, and so on. In sexagesimal measure, supplement of $A = 180^\circ - A$. In circular measure, supplement of $A = \pi - A$.

VII. *Trigonometrical Conception of an Angle—Functions of Angles exceeding 90°—Use of the Signs + and −.* The trigonometrical idea of an angle being a quantity to be calculated rather than, as in Geometry, a shape to be drawn, we find ourselves quite untrammelled by compass and pencil, and may therefore deal not only with angles exceeding 180°—which a geometer could only describe as angles turned inside out—but with angles of *any* number of degrees whatever, even exceeding 360°. We shall, however, find that the functions of every angle exceeding 90° are the functions of some angle below 90°, so that practically we have no need to calculate ratios for angles out of the first quadrant. Indeed, it is obvious that Fig. 2 cannot possibly be constructed for any angle not less than a right angle.

It is a conventional arrangement in this science that all positive angles (for definition of negative angles see Section IX.) are supposed to start from above a kind of horizontal base-line, which forms one side of the angle, the other being supposed free to revolve, in the direction of the arrows in Fig. 6, through an arc of any number of degrees, whether greater than an entire revolution or not. In Fig. 6 let A C be the "base-line" of the angle C A B (less than 90°, or "in the first quadrant"). Produce C A to G. Now let A B, the "free side," revolve to the

position A D, making D A G = C A B, and A D = A B. Then C A D is more than 90° and less than 180°, or is "in the second quadrant." Now there is clearly no way of constructing for the angle C A D, the right-angled triangle which played so important a part

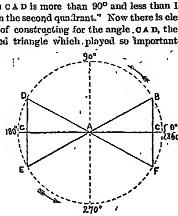


FIG. 6.

in Fig 2, in determining the ratios of the angle then being examined, but by dropping the perpendicular D G on to C A produced. Sin. C A D is therefore $\frac{DG}{AD}$. But $\frac{DG}{AD}$ is also sin. D A G;

$$\therefore \sin. CAD = \sin. DAG.$$

But since D A G = C A B, and triangle A D G evidently = triangle A B C, $\frac{DG}{AD} = \frac{BC}{AB}$;

∴ sin. C A D (an angle in *second* quadrant) = sin. C A B (an angle in *first* quadrant).

But since C A B = D A G, C A B is the supplement of C A D; therefore, generally,

$$\left.\begin{array}{l}\sin. (\pi - A) = \sin. A; \\ \text{or, } \sin. (180^\circ - A) = \sin. A.\end{array}\right\} \ldots\ldots (28)$$

From this it appears that the same ratio applies to more than one angle. A remedy for the confusion which might thus arise is found in the following arbitrary use of the signs + and −.

A perpendicular drawn *upward* from a given base is considered opposite in sign from a perpendicular drawn downward; and a line drawn to the *right* of a given point of opposite sign to a line drawn towards the *left* from the same point. Conventionally, lines measured to the right of a given point are regarded as +, therefore corresponding lines to the left are −; and lines drawn upward are +, and downward −.

By this arrangement it appears that, in Fig. 6, B C, D G, and A C are positive, while C F, G E, and A G are negative quantities. As no negative quantities enter into the ratios of any angle in the first quadrant, its functions are all + or positive.

We now return to the angle C A D, in the second quadrant, and find that its sine also (being, as already shown, $\frac{DG}{AD}$) contains no negative quantity, and is therefore positive. Formula (28) is therefore correct as regards sign as well as magnitude.

On the other hand, cos. C A D $= \frac{AG}{AD}$. A G being a negative quantity, we may write cos. C A D = $-\frac{AG}{AD}$. But $\frac{AG}{AD} = \frac{AC}{AB} = \cos. CAB$, ∴ cos. C A D = − cos. C A B.

$$\left.\begin{array}{l}\therefore \cos. (\pi - A) = -\cos. A; \\ \text{or, } \cos. (180^\circ - A) = -\cos. A;\end{array}\right\} \ldots (29)$$

And the cosine of an angle in second quadrant is *negative*.

Let A D now revolve to the position A E, giving us the trigonometrical angle C A E, in the third quadrant—*i.e.*, of more than 180°, and less than 270°. (This must not be mistaken for the geometrical angle lying below the lines C A, A E, but is the trigonometrical angle subtended by the arc C D E.) Making E A G = C A B, and noting that the lines A G and E G are both negative, but equal in magnitude to A C and B C respectively, it appears that

$$\sin. CAE = \frac{-EG}{AE} = -\frac{EG}{AE} = -\frac{BC}{AB} = -\sin. CAB.$$

$$\cos. CAE = \frac{-AG}{AE} = -\frac{AG}{AE} = -\frac{AC}{AB} = -\cos. CAB.$$

$$\left.\begin{array}{l}\therefore \sin. (180^\circ + A) = -\sin. A; \\ \cos. (180^\circ + A) = -\cos. A;\end{array}\right\} \ldots\ldots (30)$$

and the sine and cosine of an angle in the third quadrant are both negative.

If A E revolve further to A F in the fourth quadrant, making a (trigonometrical) angle C A F of more than 270°, but less than 360°, then, making C A F = C A B, and noting that F C is negative and A C positive, we find by precisely similar reasoning that

$$\left.\begin{array}{l}\sin. (360^\circ - A) = -\sin. A; \\ \cos. (360^\circ - A) = \cos. A.\end{array}\right\} \ldots\ldots (31)$$

Thus the sine of an angle in the fourth quadrant is negative, and the cosine positive.

Generally, therefore (omitting reference to sign), the function of an angle in the second quadrant is the function of its defect from two right angles; in the third quadrant, the function of its excess over two right angles; in the fourth quadrant, the function of its defect from two right angles. And since the further revolution of A F into the fifth or any succeeding quadrant will only involve a repetition of the calculations already gone into, we may still further generalise this statement, and say that *a function of any angle is the same function*

of the difference between it and the nearest even number of right angles. Thus, taking into account the signs which affect the different quadrants, sin. $200° =$ sin. $(200 - 180)° = -$ sin. $20°$; sin. $275° =$ sin. $(360 - 275)° =$ sin. $-85°$; sin. $420° =$ sin. $(420 - 360)° =$ sin. $60°$, and so on.

Since tan. $A = \frac{\text{sin. } A}{\text{cos. } A}$, and cot. $A = \frac{\text{cos. } A}{\text{sin. } A}$, hoth tan. and cot. are $+$ in the first and third quadrants, where sin. and cos. have the same sign, and $-$ in the second and fourth, where sin. and cos. have different signs. And since sec. $A = \frac{1}{\text{cos. } A}$, and cosec. $A = \frac{1}{\text{sin. } A}$, sec. will have always the same sign as cos., and cosec. the same as sin.

It is clear from this section that if we know the signs of hoth sine and cosine of an angle, we know the quadrant to which it belongs.

VIII. *Value of Functions of* $0°$, $90°$, $180°$, *and* $270°$.—Let angle $A = \text{CAB}$ in Fig. 6.—Then sin. $A = \frac{\text{BC}}{\text{AB}}$. Now if $A = 0$ (*i.e.*, represents no opening at all), AB must coincide with AC, and BC disappear altogether;

$$\therefore \text{sin. } 0° = \frac{0}{\text{AB}} = 0.$$

The other functions of angles $180°$ and $270°$, except as below stated, are easily ohtained as hefore, and appear in the following table, which sums up the results of the last two sections:—

Ratio.	0 or 360°.	In 1st Quadrant. 0° to 90°.	90°.	In 2nd Quadrant. 90° to 180°.	180°	In 3rd Quadrant. 180° to 270°.	270°	In 4th Quadrant. 270° to 360°.
Sine	0	$+(0$ to $1)$	1	$+(1$ to $0)$	0	$-(0$ to $1)$	-1	$-(1$ to $0)$
Cosine	1	$+(1$ to $0)$	0	$-(0$ to $1)$	-1	$-(1$ to $0)$	0	$+(0$ to $1)$
Tangent ..	0	$+(0$ to $\infty)$	∞	$-(\infty$ to $0)$	0	$+(0$ to $\infty)$	$-\infty$	$-(\infty$ to $0)$
Cotangent.	∞	$+(\infty$ to $0)$	0	$-(0$ to $\infty)$	$-\infty$	$+(\infty$ to $0)$	0	$-(0$ to $\infty)$
Secant	1	$+(1$ to $\infty)$	∞	$-(\infty$ to $1)$	-1	$-(1$ to $\infty)$	$-\infty$	$+(\infty$ to $1)$
Cosecant..	∞	$+(\infty$ to $1)$	1	$+(1$ to $\infty)$	$-\infty$	$-(\infty$ to $1)$	-1	$-(1$ to $\infty)$

Since 0 is the utter negation of all quantity, it is impossihle to attach a sign to it. This accounts for the ahsence of the *minus* sign—evidently required hy the symmetry of the above table—against sin. and tan. $180°$, and cos. and cot. $270°$. From this cause erroneous values (as regards signs) would he obtained for cosec. $180°$ and sec. $270°$ if we trusted in their case to formulæ (14) and (15), lately adverted to. To find cosec. $180°$. By (20),

$$\text{cosec. } 180° = \frac{\text{sec. } 180°}{\sqrt{\text{sec.}^2\, 180° - 1}} = \frac{-1}{\sqrt{1-1}} = \frac{-1}{0}$$
$$= -\frac{1}{0} = -\infty.$$

To find sec. $270°$. By (23), (10), and (24),

$$\text{sec. } 270° = \frac{\text{cosec. } 270°}{\text{cosec.}^2\, 270° - 1} = \frac{-1}{1-1} = -\frac{1}{0} = -\infty.$$

Again, cos. $A = \frac{\text{AC}}{\text{AB}}$. But if $A = 0$, $\text{AC} = \text{AB}$.

$$\therefore \text{cos. } 0° = 1.$$

Whence, by (11), tan. $0° = \frac{\text{sin. } 0°}{\text{cos. } 0°} = \frac{0}{1} = 0.$

And by (12), cot. $0° = \frac{\text{cos. } 0°}{\text{sin. } 0°} = \frac{1}{0} = \infty$ (infinity).

Similarly, by (14) and (15),

$$\text{sec. } 0° = 1\text{; cosec. } 0° = \infty.$$

Now let $A = 90°$; then (referring to same figure), BC will plainly coincide with and be equal to AB, and AC disappear.

$$\text{Then, sin. } 90° = \frac{\text{BC}}{\text{AB}} = 1;$$

$$\text{cos. } 90° = \frac{\text{AC}}{\text{AB}} = \frac{0}{1} = 0.$$

Whence, by the formulæ above quoted—

$$\text{tan. } 90° = \infty,$$
$$\text{cot. } 90° = 0,$$
$$\text{sec. } 90° = \infty,$$
$$\text{cosec. } 90° = 1.$$

When, at $180°$, AB (or AD) again coincides with AG, DG disappears, and

$$\text{sin. } 180° = \frac{\text{DG}}{\text{AG}} = 0;$$

also cos. $180° = \frac{\text{AG}}{\text{AD}}$. But AG is negative;

$$\therefore \text{cos. } 180° = -1.$$

If AB (represented now by AE) revolve further to $270°$, EG coincides with AE, and AG disappears.

Then, sin. $270° = \frac{\text{EG}}{\text{AE}} = -1$ (for EG is negative),

$$\text{cos. } 270° = \frac{\text{AG}}{\text{AE}} = \frac{0}{\text{AE}} = 0.$$

This proves indirectly that sin. and tan. $180°$, and cos. and cot. $270°$, have merely lost their *minus* sign through the accident of being represented, as to value, hy 0.

It will be observed in the above table that no ratio changes its sign except in passing through the values 0 or ∞.

The curious diagram on the next page (Fig. 7) shows at a glance the fluctuations in the value of the several ratios in passing through the four quadrants, and will be more easily borne in mind by many than any written account. Its evident symmetry and completeness also indicate the justice of employing the signs $+$ and $-$ in the arbitrary manner before explained. The propriety of so using those signs in dealing with lines can, however, he proved mathematically. Trigonometry, in its higher form, has been defined as "the consideration of alternating or periodic magnitude," and these words

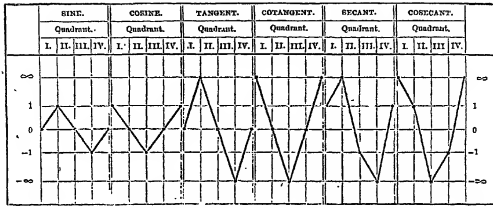


FIG. 7.—TABLE SHOWING THE VARIATION IN RATIO OF SINE, COSINE, TANGENT, ETC.

will be more easily grasped by the pupil with this diagram before him.

IX. *Negative Angles.*—An angle starting from *below* the base-line A C in Fig. 6, by the movement of its free side in a direction contrary to the arrows, is called a *negative angle*, and takes the minus sign. Its four quadrants are, of course, reckoned the reverse way; whence it follows, since the first quadrant of a negative is the fourth of a positive angle, and the second of a negative is the third of a positive angle, that for any given quadrant of a negative angle the sine differs in sign from the corresponding quadrant of a positive angle, but the cosine is always the same. This is plain from inspection of Fig. 6. Thus we say, generally—

$$\left.\begin{array}{l} i.e., \sin.\,(-A) = -\sin.\,A, \\ \text{but } \cos.\,(-A) = \cos.\,A \end{array}\right\} \quad \ldots \quad (32)$$

SOLUTION OF RIGHT-ANGLED TRIANGLES.

X. *Solution of Right-angled Triangles.*—Every triangle consists of six "elements," three sides and three angles. Any three of these being given, *including at least one side* (this is necessary, because triangles merely equiangular can be constructed in infinite number), Trigonometry enables us to calculate the remaining elements. The formulæ evolved as yet only enable us to do this for right-angled triangles, and as these involve one known quantity (the right angle), it is sufficient if any *two* of the other elements (including one side) be given. We may have (referring to Fig. 3), besides the right angle—

(1) Given two sides.
(2) Given one side and one angle.

Either of these cases may be solved by the ratios given in Section II., and by a table of natural sines and cosines, tangents and cotangents, such as that given at the end of Galbraith and Haughton's "Trigonometry." The following examples may all be solved by the annexed table of ratios for a few angles only, purposely restricted to three places of decimals:—

I.	Sines of Angles in Column I.	Tangents of Angles in Column I.	
15°	0·259	0·268	75°
24°	0·407	0·445	66°
29°	0·485	0·554	61°
30°	0·5	0·577	60°
34°	0·559	0·674	56°
36°	0·588	0·727	54°
50°	0·766	1·192	40°
54°	0·809	1·376	36°
61°	0·875	1·804	29°
75°	0·966	3·732	15°
	Cosines of Angles in Column II.	Cotangents of Angles in Column II.	II.

First, given two sides only, viz. $a = 15·58$; $b = 35$. Find A, B, and c.

$$\text{Tan. } A = \frac{a}{b} = \frac{15·58}{35} = ·445.$$

Referring to the table, we find ·445 entered as tangent of 24°.

$$\therefore A = 24°, \quad \text{and } B = 90° - A = 66°.$$

By Euclid I. 47, $c^2 = a^2 + b^2$.

$$\therefore c = \sqrt{a^2 + b^2};$$

which may readily be calculated, a and b being known.

Again, given one side and hypothenuse, viz. $b = 5$; $c = 10$. Find A, B, and a.

$$\text{Cos. } A = \frac{b}{c} = \frac{5}{10} = \cdot 5;$$

$\therefore$ by the tables, $A = 60^\circ$; $\therefore B = 30^\circ$.

a (from Euclid I. 47, as before) $= \sqrt{c^2 - b^2} = \sqrt{75}$.

Secondly, given one side and one angle, viz., $a = 100$; $B = 36^\circ$. Find A, b, and c.

$$A = 90^\circ - B = 54^\circ.$$

Since

$$\tan. B = \frac{b}{a}, \quad b = a \tan. B = 100 \times \cdot 727 = 72\cdot 7;$$

and since

$$\cos. B = \frac{a}{c}, \quad c = \frac{a}{\cos. B} = \frac{100}{\cdot 809} = 123\cdot 609.$$

Again, given hypothenuse and one angle, viz. $c = 75$; $A = 15^\circ$. Find B, a, and b.

$$B = 90^\circ - A = 75^\circ.$$

Since

$$\sin. A = \frac{a}{c}, \quad a = c \sin. A = 75 \times \cdot 259 = 19\cdot 425;$$

and since

$$\cos. A = \frac{b}{c}, \quad b = c \cos. A = 75 \times \cdot 966 = 72\cdot 45.$$

These are merely specimens of the ways in which the four cases may be treated. It will be found that other ratios might be taken equally well in several instances.

EXERCISE 2.

1. If $a = 80\cdot 669$ and $b = 17$, find c, A, and B.
2. If $c = 340$ and $B = 29^\circ$, find a, b, and A.
3. If $b = 4\cdot 5$ and $B = 34^\circ$, find a, c, and A.
4. If $A = 61^\circ$ and $b = 22$, find a, c, and B.
5. If $a = 670$ feet and $b = 333$ yards 1 foot, find c, A, and B.
6. If $a = 1764$ and $c = 3000$, find b, A, and B.
7. If $A = 75^\circ$ and $c = \cdot 005$, find a, b, and B.
8. If $b = \cdot 875$ and $a = 1$, find A, B, and a.
9. If $c = 120$ and $a = 77\frac{1}{2}$, find A and B.
10. A house 50 feet high abuts upon a street found to measure 33·7 feet in width. Find the length of ladder required to reach the top from the opposite side of the street, and the angle the ladder will make with the wall of the house.
11. Two trains travelling, one at 20 miles an hour, the other faster, come into collision at a level crossing, where the two lines (both being free from curves) cross each other at an angle of 30°. Some time before the collision, a passenger in the slower train observes the other exactly abreast of him on the other line of railway, and judges the trains to be a quarter of a mile apart. How far from the crossing were both trains at that moment, and what was the speed of the faster train?

KEY TO EXERCISE I.

1. Sin. $A = \cdot 6247$. 2. Sin. $A = \cdot 8030$.
3. Cos. $A = \cdot 9766$. 4. Sin. $A = \cdot 8$. 5. Cot. $A = 2$.
6. Sin. $A = \cdot 866$; cos. $A = \cdot 5$; tan. $A = 1\cdot 732$; cot. $A = \cdot 5773$; sec. $A = 2$; cosec. $A = 1\cdot 1547$; covers. $A = \cdot 134$.
7. $= \frac{1}{\sin. A} - \sin. A = \frac{1 - \sin.^2 A}{\sin. A} = \frac{\cos.^2 A}{\sin. A} = \cos. A \, . \, \frac{\cos A}{\sin. A}$ $= \cos. A \, . \cot. A$.
8. $= \frac{1 + \cos. A}{1 - \cos.^2 A} = \frac{1}{1 - \cos. A}$.

ELECTRICITY.—VIII.

[Continued from p. 252.]

MEASUREMENT OF RESISTANCES.

BY THE SUBSTITUTION METHOD—BY THE DIFFERENTIAL GALVANOMETER—BY THE WHEATSTONE BRIDGE.

A GALVANOMETER supplies us with the means for measuring the strength of the current flowing through any circuit, and in a modified form it may be used for determining the E.M.F. that is driving the current between any two points in that circuit, but it does not supply us directly with the means for measuring a resistance; indirectly, however, it is used for this purpose, since it forms an essential part of the apparatus by means of which resistances are usually measured.

METHOD OF SUBSTITUTION.

The most obvious method of measuring a resistance is supplied by a simple application of Ohm's law, and is known as the "method of substitution." The necessary apparatus consists of a battery, a key, a galvanometer, and a box containing a number of known resistances made up in the manner shown

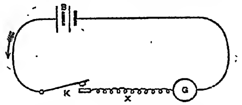


Fig. 35.

in Fig. 1., lesson I. These are arranged as shown in diagram 35.

In this diagram B is the battery, G is the galvanometer, X is the resistance which is to be measured, and K is the key used for completing the circuit when required. On completing the circuit by depressing the key a current starts from the battery, flows through the key K, the resistance X, the galvanometer G, and then returns to the other pole of the battery; this current produces a certain deflection on the galvanometer, which is carefully read, and noted. The resistance X is now taken away, and the box containing the known resistances is substituted for it; again the key is depressed, and again the current circulates and produces another deflection on the galvanometer the

amount of which clearly depends upon the strength of the current, and this current in its turn depends upon the amount of resistance in the circuit. If the resistance in the second case is exactly the same as in the first case, the two currents must be equal, and the galvanometer deflection will then be the same in each case; but if the resistances are not equal, the currents, and consequently the deflections, will be unequal. The known resistance is now varied until the deflection on the galvanometer is exactly the same as it was in the first case, and when this state of things has been arrived at, we know that the resistance X is equal to the known resistance in the box. The method can be better considered by using symbols, thus:—

Let E = the E.M.F. of the battery
„ B = resistance of the battery
„ R = the known resistance which produces the same deflections as X.

Then using the form of Ohm's law, $R = \frac{E}{C}$, we get for the first case

$$B + X + G = \frac{E}{C},$$

and for the second case

$$B + R + G = \frac{E}{C};$$

but since the E.M.F. is the same in both cases, and the current also the same—as is shown by the deflections on the galvanometer being the same—and since things that are equal to the same thing are equal to one another, therefore

$$B + R + G = B + X + G;$$

but the resistances of both B and G are the same in each case, therefore

$$R = X.$$

This method is most accurate when *the resistance of the galvanometer is equal to that of the remainder of the circuit.*

This is a very simple method of measuring a resistance, and almost any kind of galvanometer can be employed; but there are two strong objections to its use. The method depends upon the E.M.F. of the battery remaining quite constant during the whole time of working, and for this reason the battery used must be one upon the constancy of whose E.M.F. we can thoroughly depend. Again, the method depends upon all the resistances external to X and R remaining constant during the whole time of working; the only one of these that can change is the resistance of the battery, and as a matter of fact there are few, if any, batteries in common use in which the resistance does not change during working. Leclanché cells should on no account be used, but Daniell's, or better still, accumulators, can be relied upon within ordinary limits to keep both E.M.F. and resistance constant during the time of working.

Both these objections to the method of substitution would be got rid of if the method was modified in the following manner:—instead of using a single galvanometer use two which are exactly alike—that is to say, which have exactly the same resistance, and on which equal deflections will correspond to equal currents. Connect up as shown in diagram 36. With these connections, on

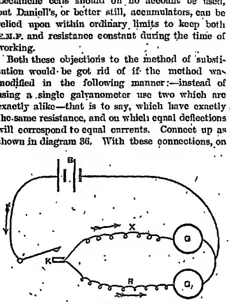


Fig. 36.

depressing the key the current will divide into two portions, one of which will flow through X and G, and the other through R and G_1. The deflections on the galvanometers show at a glance whether these currents are equal or not, and if they are not they can quickly be made so by adjusting the variable resistance R. When the deflections on the two galvanometers are the same, we then know that

$$R = X.$$

It will at once be noticed that the two main objections to the previous method do not apply to this, for the reason that the two currents are measured at exactly the same instant, and therefore, that a change in either the E.M.F. or the resistance of the battery during working affects both currents in exactly the same manner. Any source, therefore which is capable of supplying a sufficiently strong continuous current can be used with this method of measurement. Another objection that applies equally to both the above methods of measurement is, that it is necessary to read accurately the deflection of the needle. A small mistake in reading the deflection often corresponds to a large error in determining the resistance.

This method also has points about it which are objectionable. It is comparatively easy to obtain two galvanometers having the same resistance, but it is not so easy to obtain two galvanometers which

will give equal deflections for equal currents. There is a third method of measuring a resistance, by

THE DIFFERENTIAL GALVANOMETER,

which possesses all the advantages of the second method without its disadvantages. The principle of this method is shown in Fig 37. The galvano-

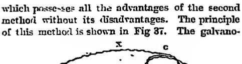


Fig. 37.—Differential Galvanometer.

meter consists of two distinct coils of wire, each having the same resistance, and having equal magnetic effects upon the needle. These coils C and C' are wound in opposite directions, as shown, and one end of each is joined to the same terminal on the frame of the galvanometer; the other ends are joined to separate terminals also situated on the frame. When a current flows through one of these coils, it deflects the needle through a certain angle in one direction; and if the same current flowed through the other coil, it would also deflect the needle, but in the *opposite direction*; if the same strength of current is sent through both coils at the same time, each coil will tend to deflect the needle, but as they tend to deflect it in opposite directions, and as the forces they exert on it are equal, the consequence is that the needle being acted upon by two equal and opposite forces *must remain at rest*. A galvanometer constructed on this principle is known as a "Differential Galvanometer."

Such a galvanometer may contain one or more bobbins, each of which contains two coils, or it may contain two bobbins. each of which is wound with a single coil. When the latter device is adopted, the coils have exactly the same resistance, and are so situated that they exert equal magnetic effects on the needle; when constructed on this principle, and when the needle is suspended by a silk fibre as is usual, the greatest care must be taken that the galvanometer is always worked in exactly the same position, and this position should be ascertained by a spirit-level fixed on the instrument. If the galvanometer happens to be used in any other position, the needle will hang nearer to one coil than to the other, and will be more influenced by that coil to which it is nearer; the consequence will be that equal currents in the two coils will exert *unequal* magnetic effects on the needle, and wrong measurements will therefore be made.

The best way to construct the instrument is to wind both coils side by side on the same bobbin. The wire used should be double silk-covered, and should be of the same diameter for both coils. Both coils should be wound at the same time on the bobbin, and before the winding is quite finished both coils should be cut, and their resistances adjusted till they are the same. The winding is then finished off, the bobbin placed in position, and the needle suspended.

The next operation is to adjust the coils so as to exert equal magnetic effects on the needle. If the coils are perfectly symmetrically wound, this operation is unnecessary, but as perfectly symmetrical winding is an impossibility the adjustment is a necessity. The adjustment is made by sending the same current in series through the two coils, but in opposite directions. If the instrument was all right there would be no deflection; but as more usually happens, there is a deflection, which shows that one coil exerts a stronger magnetic effect on the needle than the other. A couple of turns of wire are then unwound from the stronger coil and the test again applied. These operations are repeated till no deflection is produced, however strong the current may be. It may often be sufficient to unwind a quarter, or a still smaller portion of a turn of wire, in order to bring about the correct adjustment. The ends of the wire thus unwound must on no account be cut off, but must be coiled in the base of the instrument; if they were cut off, the equality of resistance of the two coils would be destroyed.

Resistances can be quickly and accurately determined by means of the differential galvanometer. An adjustable resistance box R must of course be used with it, and the resistances in this box must be varied till the galvanometer gives no deflection when the current is passing. When this state of things has been arrived at, the known resistance in the box R is equal to the unknown resistance X. It frequently happens that the needle cannot be brought quite to rest by varying the resistances R, thus, a resistance of R produces a certain deflection, whilst a resistance of $R + 1$ produces a deflection in the opposite direction; the true resistance of X then clearly lies between R and $R + 1$; its amount can be approximately determined thus:—

Let a be the number of degrees of deflection on the galvanometer when a resistance R is in circuit.

Let b be the deflection in the opposite direction when a resistance $R + 1$ is in circuit.

Then the true resistance of X is

$$R + \frac{a}{a + b}$$

Measurements made with the differential galvanometer are most accurate when *the resistances*

measured are about three times as great as the resistance of either coil.

THE WHEATSTONE BRIDGE.

This method is usually the most convenient, and certainly is the most commonly adopted for measuring a resistance. The principle upon which it works is usually a source of mystery to the beginner, and for this reason it may be well to consider its water analogy, and to see what happens when a stream of water divides into two channels which are themselves joined by a third. Fig. 38 illustrates such a case. The water is driven through the two channels *a b c* and *a d c* under the influence of a certain pressure exerted upon it at *a*. The question that we want to investigate is, does any flow of water take place through the connecting pipe *b d*, and if it does, in what direction does it take place? The answer to this question depends upon our knowledge of the pressures at the ends of this connecting pipe. If the pressure at *b* is greater

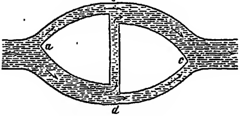


Fig 38.—Cross Water Channel.

than the pressure at *d*, then water will flow through the pipe from *b* towards *d*; and if the pressure at *d* is greater than the pressure at *b*, then water will flow through the pipe from *d* to *b*; but if the pressure at *b* is equal to the pressure at *d*, then no flow of water will take place through the pipe. In Fig. 38 the pressure at *d* is greater than the pressure at *b*, and consequently water flows through the connecting pipe from *d* to *b*.

Fig. 39 illustrates the case in which the original stream divides into two equal streams, which are connected by a pipe opening into them at equal distances from the point *a*. The pressure at *b* is now clearly equal to the pressure at *d*, and as both these equal pressures tend to drive water through the connecting pipe in opposite directions, the consequence will be that no water will flow.

A third case is illustrated in Fig. 40. In this case the original current divides into two unequal portions which are joined by the connecting pipe at the points *b* and *d*, where their pressures are equal; there is consequently no flow of water through the pipe *b d*. Any instrument capable of indicating the flow of water placed in the pipe *b d* would tell us at once what was taking place in that pipe.

The flow of electric currents through the arms of the Wheatstone bridge should be easily understood by a careful consideration of the above cases:

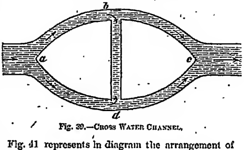


Fig. 39.—Cross Water Channel.

Fig. 41 represents in diagram the arrangement of the battery, resistances, and galvanometer. There are two keys, K and K_1, placed in the circuit whose uses will be subsequently explained; for the present, the diagram will be considered as if these keys did not exist, and as if the currents flowed permanently through the circuits as is indicated by the arrow-heads.

The current on leaving the battery flows to the point A, where it divides into two portions; one of these portions flows through the resistances r_1 and r_3 to the point C; the other portion flows through the resistances r_2 and r_4 to the point C; and both then unite and flow back to the other pole of the battery. The currents are driven through these resistances under the influence of a certain electric pressure, known as the E.M.F. This pressure, or E.M.F., has its highest value at the point A, and falls off uniformly—as was the case with the water—to its smallest value at the point C. Will any current flow between B and D through the galvanometer,

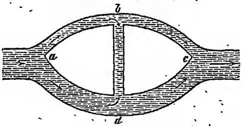


Fig. 40.—Cross Water Channel.

and, if so, in what direction will it flow? The answer is similar to the answer in the case of the water analogy. If the electric pressure, or E.M.F., at B is greater than that at D, then a current will flow through the galvanometer from B to D; if it is greater at D than at B, then a current will flow

through the galvanometer from D to B; but if the E.M.F. at B is the same as that at D, then no current will flow through the galvanometer. *When, therefore, there is no deflection on the galvanometer, the E.M.F. at B must be equal to the E.M.F. at D.* This state of things is known as a *balance*. A balance on the Wheatstone bridge, therefore, means that the two points to which the galvanometer is attached are at the same E.M.F., and when this is the case, then

$$r_4 = \frac{r_2 \times r_3}{r_1}.$$

That this is the case can be simply proved when we consider that the E.M.F. falls uniformly along a resistance; thus—

Considering the upper branch of the circuit,

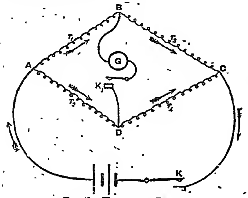


Fig. 41.—Wheatstone Bridge.

let the length of the horizontal line A B (in Fig. 42) represent the resistance r_1, and the line B C the resistance of r_3.

Let the height of the line E represent the E.M.F. at the point A, and let the height of the line e represent the E.M.F. at B.

In Fig. 43, let the resistances in the lower branch of the circuit be similarly represented by A_1 D, D C_1, and the E.M.F.'s at the points A and D by the lines E_1 and e_1.

Now, considering Fig. 42, it is clear that

$$\frac{E}{e} = \frac{AC}{BC},$$

which can be written in the form

$$\frac{E-e}{e} = \frac{AC-BC}{BC}$$

or

$$\frac{E-e}{e} = \frac{AB}{BC} \quad \text{(I.)}.$$

Again, considering Fig. 43, we have

$$\frac{E_1}{e_1} = \frac{A_1C_1}{DC_1},$$

which can be written

$$\frac{E_1-e_1}{e_1} = \frac{A_1C_1-DC_1}{DC_1}.$$

or

$$\frac{E_1-e_1}{e_1} = \frac{A_1D}{DC_1} \quad \text{(II)}$$

But $E = E_1$, since they both represent the E.M.F. at the point A at the same instant.

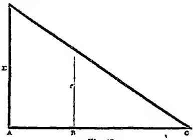


Fig. 42.

And $e = e_1$, since no current flows through the galvanometer;

$$\therefore \frac{E-e}{e} = \frac{E_1-e_1}{e_1}$$

and therefore

$$\frac{AB}{BC} = \frac{A_1D}{DC_1} \quad \text{(III.)}.$$

But $AB = r_1$, $BC = r_3$, $A_1D = r_2$, and $DC = r_4$; substituting these values in (III) we get

$$\frac{r_1}{r_3} = \frac{r_2}{r_4},$$

which clearly can be written in either of the forms

$$r_1 \times r_4 = r_2 \times r_3,$$

or

$$r_4 = \frac{r_2}{r_1} r_3$$

And it is in this last form that the formula is of practical use: r_4 represents the unknown resistance

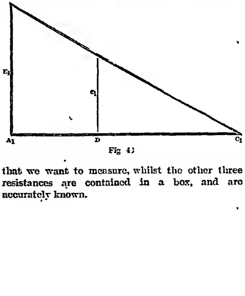


Fig 43

that we want to measure, whilst the other three resistances are contained in a box, and are accurately known.

The Wheatstone bridge, as usually made up, contains three sets of known resistances—r_1, r_2, and r_3. Both the sets of resistances in r_1 and r_2 are exactly alike, and each contains three resistance coils—one of 10 ohms, one of 100 ohms, and one of 1,000 ohms. These resistances, r_1 and r_2, are called the *ratio arms* of the bridge.

The third arm of the bridge, r_3, contains resistance coils which will make up any resistance between 1 and 10,000 ohms. It usually contains sixteen coils, having the following values:—1, 2, 2, 5, 10, 10, 20, 50, 100, 100, 200, 500, 1,000, 1,000, 2,000, and 5,000 ohms.

When measuring a resistance, *only one* resistance coil should be used in each of the ratio arms. The third arm, r_3, is then adjusted till no current flows through the galvanometer; and when balance is thus obtained, the unknown resistance can be determined in terms of r_1, r_2, and r_3, as already shown. If it is not desired to determine the value of the unknown resistance to a greater degree of accuracy than 1 ohm, the ratio arms should be made equal, and the variable resistance, r_3, adjusted till balance is obtained; in this case the unknown resistance is equal to r_3, the adjustable arm; thus

$$r_4 = \frac{r_2}{r_1} \times r_3;$$

but

$$r_2 = r_1,$$

$$\therefore \; r_4 = r_3.$$

In this case, r_1 and r_2 should both be either 10, 100, or 1,000 ohms, and that one should be selected which is nearest to the resistance whose value is being determined. For small resistances it will be found that the ratio $r_1 = r_2 = 10$ ohms will be the most sensitive arrangement; for intermediate resistances the ratio $r_1 = r_2 = 100$ ohms will be the most sensitive; and for high resistances the ratio $r_1 = r_2 = 1{,}000$ ohms will be the most sensitive arrangement.

If it is desired to determine the value of the unknown resistance to a greater degree of accuracy, the arm r_1 should be made ten times as great as r_2—that is to say, r_1 should be made 100 ohms, and r_2 10 ohms; or, r_1 should be made 1,000 ohms, and r_2 100 ohms. With this arrangement, on obtaining a balance by adjusting r_3, the value of r_4 is determined accurately to one place of decimals.

If, however, a still greater degree of accuracy is desired, r_1 should be made one hundred times as great as r_2—in other words, r_1 should be made 1,000 ohms, and r_2 10 ohms. With this arrangement of r_1 and r_2, the value of r_4 is accurately determined to two places of decimals. An example may make this clearer:—

When r_1 was equal to r_2 (it does not matter whether they were both 10, 100, or 1,000 ohms) a balance was obtained when r_3 was made 36 ohms. In this case

$$r_4 = 36 \text{ ohms}.$$

Measuring the same resistance, r_1 was made 100 and r_2 10 ohms, and it was found that in order to obtain a balance r_3 had to be made 362 ohms. In this case

$$r_4 = \frac{10}{100} \times 362$$

$$= 36{\cdot}2 \text{ ohms},$$

which gives the resistance accurately to one place of decimals.

Measuring the same resistance, r_1 was made 1,000 and r_2 10 ohms, and a balance was obtained when r_3 was made 3,623 ohms. In this case

$$r_4 = \frac{10}{1000} \times 3623$$

$$= 36{\cdot}23 \text{ ohms},$$

which is accurate to two places of decimals. It must here be observed that to obtain a theoretically perfect balance is an impossibility, since the resistances in r_3 are not infinitely small. There is always some current flowing through the galvanometer, but it may possibly be so small as to have no appreciable effect on the needle. In the general acceptation of the term, a balance is obtained when the resistance r_3 is adjusted so as to allow the smallest possible current to flow through the galvanometer.

In the above case, where the ratio arms were equal, a resistance of 36 ohms in r_3 allowed a certain current to flow through the galvanometer; but it was a much smaller current than would have flowed through it had r_3 been made any other value, such as 35 or 37 ohms. A balance was then said to be obtained when r_3 was made 36 ohms.

Again, where r_1 was made ten times as great as r_2, a resistance of 362 ohms in r_3 gave a smaller current through the galvanometer than any other resistance, such as 361 or 363. A resistance of 362 ohms therefore produced a balance.

In the third case, where $r_1 = 1{,}000$ ohms, and $r_2 = 10$ ohms, the smallest current was sent through the galvanometer when $r_3 = 3{,}623$ ohms. The 3,623 ohms produced a balance.

Though in each of the above cases a balance was procured, still a current flowed through the galvanometer, and produced a deflection in each case. If the galvanometer is so sensitive as to allow these deflections to have readable values, then a still further degree of accuracy can be obtained in determining the value of the unknown resistance, thus:—

Let 36 ohms in r_3 give a deflection of *a* degrees to one side of zero; and

Let 37 ohms give a deflection of b degrees to the other side of zero;

Then the true value of r_4 is

$$36 + \frac{a}{a+b} \text{ ohms.}$$

And the same plan might be adopted when $r_1 = 1{,}000$, and $r_2 = 10$, to obtain the resistance to three, or even four, places of decimals. It must, however, be remembered that it requires a very sensitive reflecting galvanometer to give readable deflections for such small currents, and much time is spent in reading these deflections.

Any method of measuring a resistance which depends upon the accurate reading of deflections is objectionable, since not only may errors be easily made through want of care, but they can also be made owing to the fact that the spot of light is seldom stationary, but is usually swinging over a certain range of the scale; when this is the case, the true reading must be taken as the mean position about which the spot is swinging. If no attempt is made at reading the deflections, there is not the slightest difficulty experienced in finding the balance.

When measuring a resistance, the key K must always be depressed before touching key K_1. When this is done it is sufficient barely to tap the key K_1, and so see by the direction in which the spot of light moves whether there is too much or too little resistance in r_3. When balance is nearly obtained, the key K_1 may be kept depressed for an appreciable time, but under no circumstances should either key be kept permanently depressed, unless it is desired to take readings at each side of zero. If the key K_1 is depressed before K, it is almost impossible to obtain a balance if there is any self-induction in r_4.

The Wheatstone bridge has a large range, as can be seen from the following table, which shows the range of resistances it can measure, with different ratios:—

Value of r_1.	Value of r_2.	Resistances it can measure.
1,000 ohms.	10 ohms.	From ·01 to 100 ohms.
1,000 „	100 „	„ ·1 to 1,000 „
100 „	10 „	
10 „	10 „	„ 1 to 10,000 „
100 „	100 „	
1,000 „	1,000 „	
10 „	100 „	„ 10 to 100,000 „
100 „	1,000 „	
10 „	1,000 „	„ 100 to 1,000,000 „

It is thus seen that the ordinary Wheatstone bridge can measure any resistance between ·01 of an ohm and 1,000,000 ohms.

In order to obtain the best results, *the galvanometer used should have a resistance of*

$$G = \frac{(r_1 + r_2)(r_3 + r_4)}{r_1 + r_2 + r_3 + r_4}.$$

GERMAN.—XXIX.

[Continued from p. 257.]

ADVERBS AND CONJUNCTIONS (*continued*).

Daß, demnach, denn.

Es ist kein Zwei'fel mehr, daß er uns betro'gen hat.	There is no longer any doubt that he has cheated us.
Wir sind schon fünf Stunden gegan'gen, und müssen demnach bald an der Stelle seyn.	We have already walked five hours, and, accordingly, we must soon be at the place.
Ich kann Ihnen nichts sagen, denn ich weiß kein Wort davon'.	I cannot tell you anything, for I do not know a word about it.
Ich schätze ihn höher als Feldherrn, denn als Staatsmann.	I estimate him higher as a general than as a statesman.

Dennoch, dessenungeachtet, nichtsdestoweniger.

Philipp der Gü'tige war zu sehr Verschwen'der, um Schätze zu sammeln, dennoch fand Karl der Kühne in seiner Verlas'senschaft an Ta'felgeschirren, Juwe'len, Büchern, Tape'ten, und Leinwand einen grö'ßeren Vorrath auf'gehäuft, als drei reiche Fürstenthümer damals zusam'men besa'ßen. (Schiller.)	Philip the Kind was too great a prodigal to gather treasures; nevertheless Charles the Bold found in his inheritance a greater store of table-service, jewels, books, tapestry, and linen hoarded up, than three wealthy principalities together possessed at that time.
Christ'ian der Vierte hatte sich in dem Vertra'ge von Kopenha'gen verbind'lich gemacht', ohne Zu'ziehung Schwedens keinen ein'seitigen Frieden mit dem Kaiser zu schließen, dessenun'geachtet wurde der Antrag, den Wal'lenstein ihm that, mit Bereit'willigkeit an'genommen. (Schiller.)	Christian IV had bound himself in the treaty of Copenhagen not to conclude a partial peace with the Emperor without the advice of Sweden; nevertheless, the offer which Wallenstein made him was accepted with the greatest readiness.
Doch versprach' er ihnen auf das Hei'ligste, daß diese Last sie nicht über vier Mo'nate mehr drücken solle; nichtsdestowe'niger blieben diese Truppen statt dieser vier Mo'nate, noch achtzehn im Lande. (Schiller.)	Though he promised them, in the most sacred manner, that this burden should not oppress them more than four months; nevertheless, these troops remained in the land eighteen months instead of four.

Doch, ehe, endlich.

Er hat mich zwar oft belei'digt, doch kann ich ihm nicht böse sein.	It is true that he has often offended me, yet I cannot be angry with him.
Ehe ich nach Hause gehe, werde ich zu Ihnen kommen.	I shall come to you before I go home.
Nachdem ich lange gewar'tet hatte, kam er endlich.	After I had waited for a long time, he came at last.

Entweder—oder.

Die Ü'brigen waren entwe'der bei dem geu'sischen Auf'stande mit den Waffen in der Hand gefan'gen, oder wegen ihres ehemaligen Antheils an der Bittschrift des Adels, als Hoch'verräther ein'gezogen und verur'theilt worden. (Schiller)	The remainder were either taken prisoners with their arms in their hands in the insurrection of the Gueux, or arrested and sentenced for high treason in consequence of their former participation in the petition of the nobility.

Falls.

Falls es regnen sollte, komme ich nicht.	In case it should rain, I shall not come.

Erst; dann, ferner, endlich, zuletzt.

Erst kamen drei Reiter, dann (ferner) folgte ein sin'gender Chor, und zuletzt' (endlich) auf vergol'detem Wagen die Braut und die Gäste.	First came three horsemen, then (farther) followed a singing choir, and at last (finally) the bride and the guests in (a) gilded carriage.

Folglich, gleichwohl.

Er ist mein Vater, folglich habe ich ein Recht, auf seine Liebe und sein Vermö'gen.	He is my father, consequently I have a right to his love and his fortune.
Wir gingen vo'rige Nacht erst nach zwölf Uhr zu Bett; gleichwohl' waren wir morgens um sechs Uhr wieder auf.	We did not go to bed last night till after twelve o'clock; nevertheless we were up again at six o'clock in the morning.

Je—desto, jedoch.

Vergeſ'ſen Sie nicht Ihr Versprech'en zu erfül'len; je eher, desto besser.	Do not forget to fulfil your promise; the sooner, the better.
Ich erwar'tete Ihren Sohn nicht, desto größer war aber mein Vergnü'gen, als er kam.	I did not expect your son, but my pleasure was so much the greater when he came.
Ich habe ihn gebe'ten, zu mir zu kommen, er hat es jedoch' nicht gethan'.	I requested him to come to me; he, however, has not done so.

Je nachdem, nämlich.

Sie werden belohnt' werden, je nachdem' Sie fleißig sind.	You shall be rewarded, according as you are industrious.
Alle seine Verwand'ten besuch'ten ihn; nämlich, sein Vater, zwei Schwestern, der Onkel, und eine alte Tante.	All his relatives visited him; namely, his father, two sisters, his uncle, and an aged aunt.

Nicht nur—sondern auch.

Er hat ihm nicht nur sein Geld verspro'chen, sondern auch gege'ben.	He has not only promised him his money, but also given it.

Ob.

Ich habe ihm gera'then, es nicht zu thun; ob er aber meinen Rath befol'gen wird, ist zu bezwei'feln.	I have advised him not to do it; whether he will follow my advice, however, is doubtful (to be doubted).

So.

Wie der Vater, so der Sohn.	As the father, so the son.
Hätte mein Vater für mich gesorgt', so wie ich für dich sorge, so wäre ich was An'deres gewor'den, als ein Wirth.	Had my father assisted me as I do you, I should have become something better than an innkeeper.

Sonst.

Ein Wunder mußte gescheh'en, sonst fand sie nicht einmal' den Weg zu Euch. (Schiller.)	A miracle must have happened, else she had not so much as found the way to you.

Sowohl—als, or als auch.

Aber sowohl' die Lage, als die Befe'stigung der Stadt schienen jedem An'griffe Trotz zu bieten. (Schiller.)	But the situation, as well as the fortification of the town, seemed to bid defiance to every attack.

Um so.

Du hast es nicht gethan', und das ist mir um so lieber.	Thou hast not done it, and that is so much the more agreeable to me.

Überdies.

Er ließ in aller Eile die Fe'stungswerke seiner Resi'denz' aus'bessern, versah' sie mit Allem, was sie fähig machte, eine lange Bela'gerung aus'zuhalten, und nahm noch überdies' zwei tausend Spanier in seine Mauern auf. (Schiller.)	He caused the fortifications of his capital to be repaired in the greatest haste, furnished it with all that enabled it to stand a long siege, and besides took two thousand Spaniards within its walls.

Vielmehr.

Man mag nicht mit Jedem leben, und so kann man auch nicht für Jeden leben; wer das recht einsieht, wird seine Freunde höchlich zu schätzen wissen, und seine Feinde nicht hassen, noch verfol'gen; vielmehr er'langt' der Mensch leicht einen grö'ßeren Vortheil, wenn er die Vor'züge seiner Wi'dersacher gewahr' wer'den kann.	One cannot live with everyone, neither can one live for every-one; he who rightly perceives this will highly appreciate his friends, and neither hate nor persecute his enemies: much rather do men obtain with facility a greater advantage, when aware of the superior qualities of their adversaries.

Weder—noch.

Weder verlei'ten will ich Euch zu einem falschen Schritte, noch von einem falschen zurück'halten. (Göthe.)	Neither will I persuade you to a false step, nor keep back from a false one.

Weil.

Ich will nichts mit diesem Menschen zu thun haben, weil er ein Bö'sewicht ist.	I will have nothing to do with this man, because he is a villain.

Wenn, wenn nicht.

Ich würde mit Vergnü'gen zu Dir kommen, wenn ich hoffen könnte, Dich zu Hause an'zutreffen.	I would come to you with pleasure if I could hope to find you at home.
Ich kann es nicht thun, wenn Sie mir nicht helfen.	I cannot do it. if you do not help me.

Wie.

Wie die Arbeit, so der Lohn.	As the work, so the reward.
Was hast du wie meine Sonne, wie meinen Him'mel, wie meine Fluren, wie mein geschäf'tiges, rast'loses Leben? (Herder.)	What hast thou like my sun, like my sky, like my meadows, like my busy, restless life!

PART II.

In this lesson we commence Part II. of our lessons in German. You have by this time gained a practical knowledge of the German language. You have seen how sentences are built up, and know something of the chief idioms of the language. You will now be asked to study the grammar systematically; and you will understand the difference between Part I. and Part II., if you remember that in Part I. the language is treated practically; in Part II., theoretically. From this double method of treatment, it is obvious that there will be a certain amount of repetition: but that will only serve to impress upon your mind some of the most important facts of the language.

Examples and extracts will be given throughout from the best German writers.

ETYMOLOGY.

Etymology regards words as *individuals;* discloses their origin and formation; classifies them according to signification; and shows the various modifications which they undergo in the course of declension and conjugation. The inflection of all parts of speech, except the verb, is in grammar called *declension;* the regular arrangement of the moods, tenses, numbers, persons, and participles of a verb is called *conjugation.* In a *general* way, however, *all* words capable of inflection are said to be *declinable.* The indeclinable parts of speech are often called *Particles.*

DERIVATION AND COMPOSITION.

In respect to derivation, all German words are divisible into three classes: *Primitives, Derivatives,* and *Compounds.*

The Primitives, which are also called *roots* or *radicals,* are all *verbs,* forming the basis of what are now generally called the irregular verbs, and of about fifty or sixty others, which *were* once irregular in conjugation, but are so no longer. They are also all *monosyllables,* and are seen in the crude form (so to speak) by merely dropping the suffix (en) of the infinitive mood; thus:—Bind(en), to bind; schließ(en), to close; fang(en), to catch.

From the primitives—sometimes *with,* sometimes *without,* any change in or addition to the crude form—comes a numerous train of derivatives, chiefly *nouns* and *adjectives.*

Thus, from bind(en), "to bind," we get der Band, "the volume," and der Bund, "the league," where the derivatives are produced by a mere *vowel* change. The derivative is also often distinguished by a mere euphonic or orthographic termination, changing the *form,* indeed, but in no wise affecting the *sense.* The terminations employed in this way are -er, -el, -en, -e, -de, -te, and -et; thus, from sprech(en), "to speak," comes die Sprache, "speech," "language." In some cases, moreover, in forming derivatives, the insignificant syllable ge- is prefixed, as:—Gewiß, sure, certain: der Gesang, the song.

But there is another and a most extensive class of derivatives, sometimes called *secondary* derivatives, formed by the union of radical words with suffixes that *are significant.* Thus, from heilig, "holy," "sacred," we get, by adding -en, the verb

heiligen, "to *make* holy," "to consecrate." The suffixes of this class (the *significant* ones) are, however, most of them used in forming nouns and adjectives. They will be found explained under those heads respectively. Several of them are exactly the same in *form* as the terminations which are often added to *primary* derivatives. From these (that is, from the merely orthographic endings) the significant suffixes are to be carefully distinguished.

Among the secondary derivatives must also be included those formed by means of *prefixes* as well as suffixes. These are mainly verbs, and are treated somewhat largely under the head of Compound Verbs.

GERMAN TRANSLATION.

Ein Mißverständniß.

Eines Morgens kam in ein Wirthshaus am Rhein ein junger, preußischer Offizier, und bestellte sich einen marinirten Hering, der ihm auch bald in einer Brühe mit Kapern gebracht wird.

Nicht weit von ihm sitzt ein östreichischer Offizier, der ihm freundlich anredet, und sagt: „Nicht wahr, das ist etwas gutes? Ich habe sie selbst in Italien wachsen sehen."

„Sie scheinen heiter aufgelegt," erwiedert der Preuße, „ich muß Sie aber ersuchen, mir solchen Unsinn nicht aufbinden zu wollen."

„Gar kein Unsinn; es ist mein voller Ernst."

„Lächerlich! Wie können Sie so etwas behaupten?"

„Und ich sage Ihnen, ich habe es selbst gesehen; sie wachsen auf Sträuchern."

„Und ich will jetzt keinen derartigen Scherz! Suchen Sie sich einen Andern für dergleichen lächerliche Behauptungen."

„Gar nicht Lächerliches; es ist so Sie können mir's glauben, ich habe es mit eignen Augen gesehen."

„Dann werde ich Ihnen den Staar stechen," sagte der Preuße, aufbrausend. „Ich bin es müde, mich mit solchen albernen Scherzen necken zu lassen."

„Das ist zu viel," sagt der Östreicher.

„Nun denn," fährt der Preuße, hitziger fort, „so kommen Sie morgen früh um neun Uhr in den nahen Wald mit einem Sekundanten, und ich werde Ihnen mit einer Kugel Antwort geben."

„Auch recht!" sagt der Östreicher, und trinkt seinen Wein aus.

Am nächsten Morgen treffen sich die beiden mit ihren Kameraden zur bestimmten Stunde im Wäldchen.

Das Duell wird in aller Ordnung ausgeführt. Der Östreicher, als der Beleidigte, schießt zuerst, und fehlt. Der Preuße drückt nun los, und trifft ihn im Oberarm.

Als die Wunde verbunden war, geht der Preuße auf ihn zu, und sagt: „Nun, Kamerad! behaupten Sie noch, daß die Heringe an Sträuchern wachsen?"

Treuherzig erwiedert der Östreicher: „Heringe? Ich meinte ja gar nicht die Heringe; ich meinte die Kapern!"

„Und doch habt ihr einen Zweikampf ausgefochten!" rufen alle Umstehenden.

Auerbach.

KEY TO TRANSLATION FROM GERMAN (p. 255).

THE GOOD CAMRADE.

I had a comrade, a better you cannot find. The drum beat for the battle; he kept step by my side.

A ball came flying; is it aimed at me or at thee? It has snatched him away; he lies at my feet, as it were a part of me. The hand still stretches out to me even while I am loading. I cannot give a hand to thee; remain thou in eternal life, my good comrade!

KEY TO EXERCISES.

Ex. 178.—1. In spite of the trouble which the teacher gave himself, the children would not make any sound progress. 2. He made considerable progress in the German language after he had overcome the first elements. 3. He is without the most needful books. 4. A poor family is often without the most necessary household furniture. 5. The tranquillity of this accused man rests on the consciousness of his innocence. 6. The captain told us yesterday, that the young Italian had shot a ball through his head. 7. He shot a ball through the bear's head. 8. I prefer travelling by way of Bremen or Hamburg, instead of by way of Havre. 9. I prefer riding on horseback to walking, and riding in a coach to riding on horseback. 10. I am more comfortable in a warm room than in a cold one. 11. It is most agreeable to him to be able to smoke his cigar after dinner. 12. To boys it is most pleasing and also most healthy to take half an hour's walk after dinner. 13. I had an unpleasant sensation all the morning. 14. The princes of Germany have again usurped the government. 15. The uncle contrived to usurp his nephews' property by degrees. 16. It is some time since I saw him. 17. Is it long since he fell ill? 18. Yes, it is more than three weeks already. 19. Stay at home till I come to you; I shall call on you for a walk. 20. Death calls away not only the old man, but also very often the man in his prime, the youth, and the child in the cradle. 21. As I know that my friend would arrive by the steamboat, I went to the landing-place for him. 22. I called at the post-office this morning for this letter. 23. On my journey I stayed at different inns, but I cannot praise any one of them particularly. 24. I generally call on my friends when I go to town.

Ex. 179.—1. Ich machte bessere Fortschritte in der deutschen Sprache, nachdem ich die ersten Anfangsgründe überwunden hatte. 2. Der Onkel sucht das Vermögen seiner Neffen an sich zu reißen. 3. Ist es lange, daß Ihr Bruder krank wurde? 4. Nein, es ist nicht länger, als einige Tage. 5. Werden Sie zu Hause bleiben, bis ich bei Ihnen vorspreche? 6. Es ist mir angenehmer, einen Spaziergang auf das Land zu machen, als zu Hause zu sitzen. 7. Wenn ich nach der Stadt gehe, so spreche ich gewöhnlich bei einigen meiner Freunde ein. 8. Er zieht das Studieren allen andern Beschäftigungen vor. 9. Ich ziehe das Gehen dem Reiten, und das Reiten dem Fahren vor. 10. Während der Schlacht ritt der General die Reihen entlang, um seine Soldaten anzufeuern. 11. Kindern ist es gesund, wenn sie nach der Schule spazieren gehen können. 12. Die Räuber rissen sich um die Beute, welche sie den Bürgern genommen hatten.

Ex. 180.—1. The creditors have compounded with the debtor at 50 per cent. 2. The two merchants could not agree as to the price. 3. I have compared the two together. 4. He has let the house to him for five years. 5. The young man has hired himself out as servant. 6. It is surprising that such a thing can happen in our times. 7. It surprises me that he

has survived and did not die. 8. Cicero delivered an address against Catiline. 9. He likewise delivered speeches on Friendship, on Old Age, and on various other subjects. 10. Cæsar delivered an address to his soldiers. 11. The scholar repeated once more at home that which he had heard at school. 12. We heard a repeated crying. 13. The price of these wares has risen considerably. 14. The corn has risen considerably on account of the war. 15. Prudence sometimes commands even the brave man to avoid an enemy who seeks to quarrel with him. 16. The political fugitive is obliged to avoid his fatherland. 17. One should avoid the society of a depraved man. 18. The physician visits the sick person every other day. 19. Every other day he goes hunting. 20. He acted with the same levity as a man as he had done as a youth. 21. When the Hungarian heroine Jagella and other Hungarian heroes arrived in New York, they alighted at an hotel. 22. At dinner was brought in for dessert a tower, ornamented with warlike implements, made of confectionery, on which were the words, in the German language: "Long live the Hungarian heroes and heroines."

EX. 181.—1. Der Gläubiger hat sich mit seinem Schuldner auf zwanzig Procent verglichen. 2. Ich konnte mich mit meinen Gläubigern wegen des Preises nicht vergleichen. 3. Haben Sie die Güte, eins mit dem andern zu vergleichen. 4. Ich habe mein Haus auf fünf Jahre vermiethet. 5. Ein fleißiger Schüler wiederholt das, was er in der Schule gehört hat. 6. In Kriegszeiten steigt der Preis der Lebensmittel bedeutend. 7. Es wundert mich, daß er die Gesellschaft solcher Leute nicht meidet. 8. Wir sollten die Gesellschaft derjenigen meiden, welche keine guten Grundsätze haben. 9. Ich besuche meine Schwester einen Tag um den andern. 10. Er handelt gerade, wie er in seiner Jugend handelte. 11. Alle Waaren sind dem Kaufmanne genommen worden, weil er sich mit seinen Gläubigern nicht vergleichen konnte. 12. Waffne dich Tag für Tag mit mehr Weisheit, Jüngling, denn die Blume der Jugend verblüht.

CHEMISTRY.—XV.

[*Continued from p. 261.*]

GOLD—PLATINUM—ALLOYS WITH IRIDIUM—PALLADIUM—ATOMIC WEIGHT AND DALTON'S ATOMIC THEORY—AVOGADRO'S LAW—EQUIVALENT AND MOLECULAR WEIGHT—NEWLANDS' "LAW OF OCTAVES"—THE PERIODIC LAW—ORGANIC CHEMISTRY.

Gold, Au (*aurum*, Latin), atomic weight 197, specific gravity 19·4, melts at 1,250° Cent. This, our only yellow metal, is always found native, it is widely distributed; our chief supplies are derived from Australia, California, Africa, and Hungary; it is also found in small quantities in Wales, Scotland, Ireland, etc.; native gold is never pure, it always contains silver. Gold is extracted either by washing away the sand, etc., with water, when the heavy particles of gold remain behind, or by crushing the rock in which it exists, and shaking with mercury; the mercury amalgamates with the gold, and on washing, the amalgam is left behind; it is then heated, when the mercury distils over, leaving the gold in the retort. Large quantities of gold are now obtained by the "cyanide process," in which the auriferous ores are treated with a solution of potassium cyanide in the presence of an oxidising agent, either air or bromine; the gold so forms a double cyanide with potassium, from which it is precipitated by zinc dust. Gold is the most malleable of metals, it can be beaten out into sheets $\frac{1}{250000}$th of an inch thick; this gold leaf is so thin that it allows a greenish light to pass through. The colour and general appearance of gold are well known; like silver, it is too soft to be used unalloyed, copper or brass being added to give it the requisite hardness. The coin of this realm contains 22 parts of gold and 2 of copper; it is known as 22-carat gold (pure gold would be 24-carat). Wedding-rings are supposed to be made of 22-carat gold; the best jewellery is manufactured of 18-carat gold, then we have 15-, 12-, 9-, and 7-carat gold: the last contains, of course, 17 parts of brass, or some similar alloy, and only 7 parts of gold—it is, nevertheless, called gold. 22-, 18-, 15-, 12-, and 9-carat gold can be hall-marked, *i.e.*, a number indicating the fineness of the gold is stamped on the article.

Gold is usually purified by a process called parting: the gold is alloyed with not less than three times its weight of silver; the alloy is rolled out into a thin sheet or granulated, *i.e.*, poured, while melted, from some height into water; it is then boiled with dilute nitric or strong sulphuric acid, when the silver, copper, etc., are dissolved out, leaving the gold as a fine brown spongy mass or powder. Pure gold can also be obtained by dissolving ordinary gold in aqua regia, largely diluting with water, decanting the clear fluid and adding a solution of ferrous sulphate, $FeSO_4$, sulphurous acid, H_2SO_3, or oxalic acid, $H_2C_2O_4$, when the gold will be precipitated as a brown powder.

Gold is not attacked by any ordinary acid, but dissolves in boiling aqua regia ($2HCl + 1HNO_3$). The usual test applied to articles which are supposed to be gold is to file a small nick so as to cut through any plating, and then apply a drop of strong nitric acid; if the surface is gold no action will take place, but if it is brass the drop of acid turns green and evolves red fumes. This test fails with an alloy termed "mystery gold," which contains silver, platinum, and copper; this alloy has the colour of 9-carat gold, is not acted on by strong nitric acid, and has about the same specific gravity as standard gold.

The principal salt of gold is *Gold Chloride*, $AuCl_3$; it is obtained by dissolving gold in aqua regia and evaporating the solution over steam; it is much used for "toning" photographic prints.

When a solution of stannous chloride, $SnCl_2$, is added to gold chloride a brown or purple precipitate falls, which is known as the "purple of Cassins."

Platinum (Pt), atomic weight 195, specific gravity 21·7, melts about 2,000° Cent., occurs native, especially in the Ural Mountains; it is purified from the metals which accompany it, Osmium, Iridium, Palladium, by a complicated process. It is a very heavy greyish-white metal which is quite unattacked by ordinary acids, and is only dissolved by aqua regia; it is slightly attacked by fused caustic alkalies; it does not tarnish and cannot be fused in any ordinary furnace, but melts readily in the oxyhydrogen blowpipe. It is very useful in the laboratory as a support for fusions, etc. It alloys and melts readily when heated with lead, tin, etc. The principal salt is *Platinic Chloride*, $PtCl_4$, prepared by dissolving platinum in aqua regia and evaporating the solution over steam, when the salt is left as an orange-coloured mass; it is very soluble in water; its solution is used in the laboratory, as it gives characteristic yellow crystalline precipitates with potassium and ammonium chlorides, but none with sodium chloride. The ammonium chloride precipitate, $(NH_4)_2PtCl_6$, when raised to a red heat is decomposed and leaves a mass of "spongy platinum"; this platinum sponge absorbs certain gases readily—thus if a stream of hydrogen be directed on it, it promotes the union of the hydrogen with the oxygen of the air to such an extent that the platinum becomes red-hot.

The remaining platinum metals are rare, and do not require detailed description; they resemble platinum in their high melting-points and indifference to the action of acids, etc. Some points of interest may be noted. An alloy containing one part of iridium to nine of platinum has been used with great success for standard measures of length; it is hard, strong, elastic, infusible, and not liable to tarnish. An alloy of osmium and iridium is exceedingly hard, and is used for tipping the ends of stylographic and gold pens.

Palladium has been lately employed for the hair-springs of watches, since it is not liable (like steel) to be magnetised when the watch is in the neighbourhood of a powerful dynamo.

We have now completed our survey of all the more common elements and their chief compounds, but there still remains a branch of chemistry which is so vast that we shall be able to do little more than touch upon it; this branch is what is usually known as Organic Chemistry. Before entering upon its study, it will be convenient to consider various subjects of great interest and importance, which have not been hitherto discussed at any length, and which the student will, we hope, by this time be able to appreciate.

Atomic Weight and the Atomic Theory of Dalton. Long before Dalton's time many philosophers had suggested that all matter consisted of particles which could not be further divided, and which were therefore called atoms (Greek *a*, not; and τέμνω, *temno*, to cut or divide). By a stroke of genius, Dalton, in 1808, suggested, and to a certain extent proved, that atoms had not all the same weight, but that the atom of each element had its own relative weight.

Dalton also proposed his "law of multiple proportions." *If two elements,* A *and* B, *combine to form several compounds, if we take a fixed amount of* A, *then the different amounts of* B *which combine with* A *bear simple ratio to each other: e.g.*, in olefiant gas six parts by weight of carbon combine with one part of hydrogen, in marsh gas the same weight of carbon (six parts) combines with two parts of hydrogen, etc.; this was explained by Dalton by supposing that the formation of a compound takes place by the union of atoms, and that each elementary atom has its own fixed weight as compared to hydrogen, which was taken as the unit.

Since Dalton's time the atomic weights of the elements have been determined many times with the utmost care. They are usually found by determining—

1. The smallest quantity by weight of an element which enters or leaves a chemical compound (*i.e.*, the weight of one atom); the smallest quantity of hydrogen so entering or leaving being taken as 1.

2. The specific gravity of the element in the state of gas or vapour ($H = 1$).

3. 6·4 divided by the specific heat of the element in the solid state (specific heat of water $= 1$). This only gives an approximate result.

It is obvious that with such elements as platinum, which have not yet been converted into vapour, the second method of determining atomic weights is useless, while the third plan is inapplicable to oxygen, hydrogen, etc., which cannot be obtained in the solid state under ordinary conditions.

With reference to the third method it may be explained that the specific heat of a substance is the quantity of heat required to raise the temperature of one pound of it 1° Cent., the quantity of heat required to raise the temperature of one pound of water 1° Cent. being 1·00. Thus the specific heat of bismuth is 0·03; in other words, if one pound of coal is required to raise a certain weight of water 1° Cent., only 0·03 or $\frac{3}{100}$ths of a pound

of coal will be required to raise the same weight of bismuth 1° Cent.,

$$\text{and } \frac{6 \cdot 4}{0 \cdot 03} = 213 \text{ (atomic weight Bi} = 216).$$

The Law of Avogadro.—In 1811 Avogadro, after a careful study of the physical properties of gases and vapours, propounded the hypothesis which still bears his name. *Equal volumes of all gases and vapours contain the same number of ultimate particles or molecules.* This law is now universally accepted by physicists and chemists. If this law be true, it follows that a particle of hydrogen or any other gas *in the free state, i.e.*, a molecule, can be divided into two, or in other words, contains two atoms. If we take one volume of hydrogen and an equal volume of chlorine and mix them in the light, we know by experiment that we obtain *two* volumes of hydrogen chloride, HCl (*see* Vol. IV., p. 195). Now suppose the volume of hydrogen contains 100 particles of hydrogen, it follows from Avogadro's law that the equal volume of chlorine will also contain 100 particles of chlorine, and the *two* volumes of hydrogen chloride formed will contain 200 particles of HCl; now each of these two hundred particles of HCl obviously contains both hydrogen *and* chlorine, and there must be, therefore, 200 particles of H and 200 of Cl, and these were contained respectively in the 100 particles of free H and free Cl, so that each particle of free hydrogen must be capable of division into at least two particles. The particles of the elements in the free state are termed molecules, and the ordinary molecule is said to be divisible into, or to contain, two atoms.

The number of atoms in the molecule of an element can only be determined when the element has been obtained in the state of gas or vapour, since specific gravity of a substance in the state of gas or vapour $= \frac{\text{molecular weight}}{2}$. In this way a number of molecules have been investigated: of those, H, O, Cl, Br, I, N, S (at 860° Cent.), Se, Te contain 2 atoms; Hg, Zn, Cd, A, and H_2 contain 1 atom; Ozone contains 3 atoms; P and As contain 4 atoms, and S (at 524° Cent.) contains a mixture of complex molecules.

Equivalent or Combining Weight.—For a long time the equivalent weight of an element was confused with its atomic weight; now an element can only have *one* atomic weight, but it may have several equivalent weights. The equivalent weight is most simply defined as its *atomic weight divided by its active atomicity or valency* (*see* Vol. IV., p. 324), *e.g.*, the atomic weight of oxygen is 16, in water, H_2O, oxygen is a dyad, so its equivalent weight is $\frac{16}{2} = 8$, in other words, the weight of oxygen which combines with 1 part by weight of hydrogen is 8, or 8 lbs. of oxygen are equivalent to, or can replace, 1 lb. of hydrogen. If we take iron, atomic weight 56: in ferrous oxide, FeO, iron is a dyad, and its equivalent is $\frac{56}{2} = 28$; in ferric chloride, $FeCl_3$ iron is acting as a triad, and its equivalent is $\frac{56}{3} = 18 \cdot 6$. If a current of electricity be sent through a series of solutions, *e.g.*, copper sulphate ($CuSO_4$), silver cyanide (AgCN), acidulated water (H_2O), etc., the elements will be liberated in equivalent weights, thus the current which liberates 1 lb. of hydrogen will liberate $\frac{108}{1}$ lb. silver, $\frac{65}{2} = 32 \cdot 5$ lb. of copper from $CuSO_4$, etc.

To sum up, the atomic weight is the weight of an atom (H = 1), the molecular weight is the weight of the smallest particle which can exist in the free state (H = 1), and equivalent weight is atomic weight divided by active atomicity.

Newlands' Law of Octaves, Mendeljeff's Periodic Law.—In 1864 John Newlands pointed out that by arranging the elements in the numerical order of their atomic weights, it was seen that at every 8th element there is a recurrence of similar physical and chemical characters. Some five years afterwards the same idea was worked out more fully by Mendeljeff, in his elaborate treatise on the "periodic law."

Thus, neglecting hydrogen, we have:—

Lithium	atomic weight		7	Sodium	atomic weight		23
Beryllium	,,	,,	9·5	Magnesium	,,	,,	24
Boron	,,	,,	11	Aluminium	,,	,,	27·3
Carbon	,,	,,	12	Silicon	,,	,,	28
Nitrogen	,,	,,	14	Phosphorus	,,	,,	31
Oxygen	,,	,,	16	Sulphur	,,	,,	32
Fluorine	,,	,,	19	Chlorine	,,	,,	35·5
				etc.			etc.

It is seen that the 8th element from lithium is sodium, from carbon is silicon, from nitrogen is phosphorus, from oxygen is sulphur, and from fluorine is chlorine. The similarity between these elements has already been pointed out; after the first two octaves just given it is found that a much closer resemblance is noticed between *alternate* octaves, thus the next octave to magnesium is calcium, and the 4th octave is zinc, the 5th strontium, the 6th cadmium, and the 7th barium; it is obvious that the analogous elements are the 2nd octave magnesium, 4th zinc, and 6th cadmium, and again the 3rd calcium, 5th strontium, and the 7th barium. We have not space to discuss the interesting points connected with this arrangement of the elements, but there seems no doubt that the relations indicated are too numerous and concordant to be accidental, and that this arrangement of octaves depends upon some intimate connection between the various elements at present unknown. The table has already been of great use in prophesying the existence and properties of elements which have since been discovered, *e.g.*, gallium, and in

suggesting alterations in the atomic weights of some elements, *e.g.*, tellurium, which have been justified by subsequent determinations.

Organic Chemistry.—One of the first points of difference to be noted between organic and inorganic chemistry is that while in the inorganic branch the elements which we study are numerous, but the various compounds of each element are comparatively few, in the organic portion of the subject we shall find the number of elements concerned is comparatively small, but the compounds of these elements are almost innumerable. All organic substances contain carbon, and the enormous number and complexity of the compounds of this element with hydrogen, oxygen, and nitrogen seem almost exclusively to be due to the fact that carbon has a power, almost unknown in other elements, of linking its atoms together so that we may have thirty or more atoms of carbon in one compound. Organic chemistry has therefore been defined as the *chemistry of the carbon compounds* (excluding CO, CO_2, and CS_2); others have suggested that organic chemistry may be considered as the *chemistry of compound radicles*, since just as we have in inorganic chemistry the metals or electro-positive elements, and the non-metals or negative elements, so we have in organic chemistry the positive radicles and the negative radicles; by far the larger number of the radicles are positive. Thus, just as we have the metal potassium, K_2; its hydrate, KHO; oxide, K_2O; its salts, KCl, K_2SO_4, etc., so we have the positive radicle ethyl, $(C_2H_5)_2$; its hydrate, C_2H_5HO, ordinary alcohol; its oxide, $(C_2H_5)_2O$, ordinary ether; its chloride, C_2H_5Cl; its sulphate, $(C_2H_5)_2SO_4$, etc. The most important negative radicle is cyanogen, $(CN)_2$, which resembles in many respects the halogens (chlorine, bromine, and iodine), and replaces them in many compounds.

As the analysis of organic compounds plays an important part in determining their formulæ, we will give a short account of the principles of the methods employed. As stated above, all organic bodies contain carbon; one large class, the hydrocarbons, are compounds of carbon with hydrogen; many organic substances contain carbon, hydrogen, and oxygen; another great group consist of carbon, hydrogen, oxygen, and nitrogen; others, again, contain chlorine, bromine, sulphur, etc. We shall confine our attention to the methods of estimating the great organic elements, carbon, hydrogen, and nitrogen, since oxygen is hardly ever estimated directly, but the quantity present is calculated by subtracting the sum of the weights of the other elements from the total weight of the substance analysed. The first step is to ascertain whether the substance contains nitrogen; this can usually be decided by heating some of it in a glass tube with soda-lime (*i.e.*, quick-lime slaked in a solution of sodium hydrate). If nitrogen is present, ammonia will be evolved, and can be recognised by the usual tests. *If nitrogen is absent, the analysis is conducted as follows*:—The substance is carefully and thoroughly dried, and a small quantity, about ½ gram, is very accurately weighed out, mixed with dry oxide of copper, and the mixture placed in a tube of hard glass about 2 feet long and ½ inch in diameter, with many precautions which we have not space to give in detail. The glass tube is

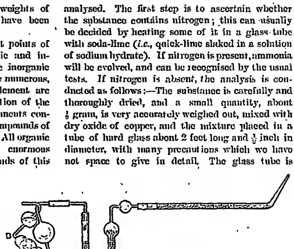


Fig. 48.

drawn out, and closed at one end (*see* Fig. 48); to the other end is fitted a U-tube, A, containing either calcium chloride, which has been previously fused to deprive it of water, or a little strong sulphuric acid; to this is attached by a short piece of india-rubber tubing a set of bulbs containing a strong solution of potassium hydrate, B; both the U-tube and the potash bulbs are very carefully weighed. On heating the tube containing the mixture of the substance with the oxide of copper, the former burns by the aid of oxygen derived from the oxide of copper, and is converted entirely into water and carbon dioxide; the water is completely absorbed by the U-tube, and the carbon dioxide by the potash bulbs. When the combustion is finished, the closed end of the combustion-tube is broken and connected with drying-tubes, and the gaseous contents slowly sucked through the U-tube and potash bulbs. The increase in weight of the U-tube gives the weight of water produced and the increase of weight of the potash bulbs the weight of carbon dioxide

To take an example:—

0·25 gram of a hydrocarbon gave 0·8085 gram CO_2 and ·2655 gram H_2O.

Now, 1 atomic weight of C = 12
2 " " " O = 32
$\overline{44}$

So that 44 parts by weight of CO_2 contain 12 parts by weight of C, or to put it in another form—

$$\frac{\text{weight of } CO_2 \times 12}{44} = \text{weight of carbon.}$$

Similarly,

$$\frac{\text{weight of } H_2O \times 2}{18} = \text{weight of hydrogen,}$$

So $$\frac{\cdot 8085 \times 12}{44} = \cdot 2205 \text{ carbon,}$$

and $$\frac{\cdot 2655 \times 2}{18} = \cdot 0295 \text{ hydrogen.}$$

·25 gram of the hydrocarbon contains therefore ·2205 gram C and ·0295 gram H:

or, 100 parts contain 88·2 parts C,
11·8 parts H.
100·0 .

LATIN.—XXX.

[Continued from p. 264.]

THE AGRICOLA OF TACITUS.

WE now propose to set before you a complete work of Roman literature. This is the life of Agricola, who was governor of the Roman province of Britain in the first century of our era, written by his son-in-law, the great historian Tacitus. We propose to tell you what is known of the life of Tacitus, to give you a brief account of his works and literary style, and then to add some account of the subject of this biography.

LIFE OF TACITUS.

Of the life of Tacitus we know but little; some facts we may deduce from his writings, others from allusions to him, or letters addressed to him in the correspondence of the younger Pliny. Even his name we do not know accurately, for though there is no doubt that his *nomen* (the name of his *gens*) was Cornelius, and that the *cognomen* (the name of his family) was Tacitus, we have no authority to enable us to decide whether his *praenomen* (his first name) was Gaius or Publius (each name being ascribed to him by different writers). His birth took place about the year 50 A.D., his death probably not earlier than 117, so that his life was passed during the reigns of some of the best and some of the worst emperors. In 78 he married the daughter of Agricola, the subject of the present memoir, and in the ensuing years held various public offices until, in 97 A.D., in the reign of Nerva, he reached the highest point of the career of honours open to the Roman citizen, and held the consulship.

WORKS OF TACITUS.

The "Agricola," which, with one unimportant exception, was his earliest work, was published in the year of his consulship; it was followed next year by the "Germania," an account of the land of Germany and the different tribes who inhabited it. This is a book of some interest, as it preserves for us a description of the manners and customs of the Teutons, of whom our ancestors, the Anglo-Saxons, formed a part. Both of these, however, were but minor works. The task to which Tacitus devoted the later years of his life was the composition of the history of the Empire, from the death of Augustus (14 A.D.) to the accession of Nerva. The latter part of the subject he treated first in the "Histories," a work published some time between 103 and 106. This was followed by the "Annals," treating of the earlier period, and showing the highest development of his literary style. Only parts of these works have come down to us, but enough remains to witness to his great powers both as an historian and as a literary artist.

STYLE OF TACITUS.

The style of Tacitus is a great contrast to that of Cicero. Cicero wrote the most correct and polished Latin, and aimed at richness of expression and well-rounded periods. Tacitus is concise and poetical. The grammarians distinguish three characteristics in Tacitus, *Brevitas*, *Varietas*, and *Color Poeticus*. Under the first heading we must notice his extreme conciseness of expression, the way in which by a happy phrase he describes an event, a motive, or a character in two or three well-chosen words. He is a master of emphasis and epigram. His *Varietas* appears most prominently in his choice of constructions; he combines together different grammatical idioms to express ideas which are exactly analogous to one another. Thus we find in the same clause singulars and plurals, adjectives and substantives, participles and gerunds, actives and passives, all being consciously used to produce the effect of variety. The "poetic tinge," which has been traced in his works, consists in the adoption of words and constructions, which had hitherto been almost confined to poetry, for the purpose of describing ordinary events in prose. This characteristic (and the others also in some degree) are generally prevalent in the so-called "Silver Age" of Latin literature. You must remember that in all languages poetry and prose are developed on different lines, and that poetry always claims for itself a greater boldness and freedom in the choice and use of words. But from Vergil onwards, Latin prose style was largely moulded by the poets. Vergil exercised an enormous influence on all later writers. Livy adopts words, phrases, and constructions from him, and Tacitus carries this tendency still further.

These characteristics you will be able to notice

in the "Agricola," but as the style of Tacitus was only gradually developed, they are not so pronounced in this work as in the "Annals," which was his last production.

THE AGRICOLA.

The life of Agricola is the most perfect biography that has come down to us from the pen of any classical writer. Tacitus had a filial affection for the hero of his work, and had also, from his intimacy with Agricola, the best means of ascertaining the true facts of his life. Moreover, the book possesses a special interest for us in the account of Agricola's campaigns in Britain. It will be best for you, before you read the book, to understand something of the Roman policy in the provinces, and in particular to learn how Britain was treated.

Agricola, the hero of Tacitus' work, represents (as Messrs. Church and Brodribb have pointed out) the highest type of Roman character. "An able officer, a just and at the same time a popular governor, a vigorous reformer of abuses, a conqueror of hitherto unknown regions, he was also a man of mental culture, and of singular gentleness and amiability." For this reason alone the biography would be well worth our study, but, as we have said, it possesses other interests for us. It contains the earliest account of our own island and its inhabitants, as well as of the campaigns of the Romans in Britain. This is not, of course, accidental. Tacitus did not neglect his subject in order to write a dissertation on a remote part of the Roman Empire, but Agricola (who lived from 38 A.D. to 93) began his official career at an early age in Britain, continued to serve in the island as a subordinate officer ten years later, and finally held the office of governor for eight years, and having subdued all opposition and carried the Roman arms further than they had ever advanced before, he returned to Rome. The last eight years of his life were passed in retirement, and Tacitus has little to tell us concerning this period. It will be seen, therefore, that Agricola's career was intimately connected with the history of events in Britain, and that in reality Britain does not occupy a disproportionate place in the biography.

THE ROMANS IN BRITAIN.

Now let us consider the general policy of the Romans in the provinces. The establishment of the Empire by Augustus Cæsar saved the Roman world from dissolution. The Republican Government had shown itself incapable of defending the vast extent of dominion which had been acquired by the Roman sword, and equally incapable of ruling effectually the diverse nations who were Rome's subjects in the provinces. The Imperial Government, on the other hand, gradually introduced peace, order, and good government; organised and controlled the provinces, and maintained the frontiers against the barbarous tribes beyond. Hence it is that the history of the first hundred years of the Empire is in its most important features the history of the settlement and defence of the provinces.

But at first Britain was not a province. Julius Cæsar, it is true, had invaded the island twice (in 55 and 54 B.C.), while he was engaged in subduing the Gauls, but his expeditions were voyages of exploration rather than of conquest. After that, as Tacitus says (chapter 13), "there was a long neglect of Britain." Augustus laid it down as a maxim of foreign policy that the frontiers of the Empire should be maintained, but not extended. This policy he himself and his successor Tiberius consistently carried out. Britain, then, lay without the bounds of the Empire; separated from the nearest Roman province of Gaul by the sea, and inhabited by wild, uncivilised tribes, it could not threaten danger to the Romans. But there was a considerable intercourse between the Britons and the Gauls. Tacitus (chapter 11) argues that the inhabitants of Southern Britain were closely related to the Gauls of the opposite coast; and it is certain that there were striking similarities in religious and other customs. Gaul had been subdued, and on the whole gave little trouble to the Romans; but there was always a certain amount of disaffection among the national party, disaffection which was kept alive by the Druids. This state of affairs the Romans could not hope to remedy as long as Britain lay near at hand as a refuge for the discontented, where they could plot revolt, and whence they could return so easily to renew their attempts. These considerations first influenced the Romans to enter Britain, with the intention of reducing it to the form of a province. It was necessary first of all to subdue the south, but when once in Britain it was difficult to stop the work of conquest, for as there was no natural frontier, the tribes outside were always a cause of danger and disturbance, and it was impossible to keep the wild and insubordinate Britons within the Roman province in check, while their independent brethren were prepared to second any revolt. The history of the Romans in Britain is, therefore, the history of the gradual advance of the Roman frontier, a work interrupted by constant revolts on the part of the Britons, who were too savage and independent to tamely submit to foreign dominion.

The course of the Roman conquest is sketched for you by Tacitus. We will briefly summarise the

chief steps in the process. In the reign of the Emperor Claudius in the year 43 A.D., Britain was invaded for the first time since Julius Cæsar. The south-eastern parts of Britain were reduced to the condition of a province, and a garrison of veterans sent to occupy it. The usual Roman policy of offering protection to native monarchs, and thus enlarging the sphere of Roman influence without the necessity of subduing the district or maintaining a garrison, was adopted (chapter 14). In the next twenty years attempts were made to subdue the more distant districts from which the rebels drew their reinforcements, and two great revolts, one headed by Caractacus in 50, and one by Boadicea in 59, took place. Both insurrections were suppressed by the strong hand of the Roman governors, and in the campaigns of the years 59–61, in which Boadicea was overcome. Agricola began his military career. But his great work began in the year 78, when he succeeded to the government of Britain. He ruled with a firm hand, encouraged the arts of peace, and vigorously pursued a career of conquest in the west and north of Britain. How he entered Scotland, and gradually overcoming resistance in the south, defeated a great combination of Caledonian tribes in the centre of the country, and how after taking hostages from the conquered, he was prevented from settling the country by the jealousy of the Emperor Domitian, we must leave you to read in the pages of Tacitus.

THE LIFE AND CHARACTER OF JULIUS AGRICOLA.
By Cornelius Tacitus.

Preface: *Biography is not acceptable to an age which prefers satire. Yet a happier time than Domitian's has arrived, and to write the life of Agricola is for Tacitus a filial duty.*

1. Clarorum virorum facta moresque posteris tradere, antiquitus usitatum, ne nostris quidem temporibus quamquam incuriosa suorum aetas omisit, quotiens magna aliqua ac nobilis virtus vicit ac supergressa est vitium parvis magnisque civitatibus commune, ignorantiam recti et invidiam. Sed apud priores ut agere digna memoratu pronum magisque in aperto erat, ita celeberrimus quisque ingenio ad prodendam virtutis memoriam sine gratia aut ambitione bonae tantum conscientiae pretio ducebatur. Ac plerique *suam ipsi vitam* narrare fiduciam potius morum quam adrogantiam arbitrati sunt, nec id Rutilio et Scauro citra fidem aut obtrectationi fuit: adeo virtutes isdem temporibus optime aestimantur, quibus facillime gignuntur. At nunc narraturo mihi vitam defuncti hominis venia opus fuit, quam non petissem incusaturus tam saeva et infesta virtutibus tempora.

2. Legimus, cum Aruleno Rustico Paetus Thrasea, Herennio Senecioni Priscus Helvidius laudati essent, capitale fuisse, neque in ipsos modo auctores, sed in libros quoque eorum saevitum, delegato triumviris ministerio ut monumenta clarissimorum ingeniorum in comitio ac foro urerentur. Scilicet illo igne vocem populi Romani et libertatem senatus et conscientiam generis humani aboleri arbitrabantur, expulsis insuper sapientiae professoribus atque omni bona arte in exilium acta, ne quid usquam honestum occurreret. Dedimus profecto grande patientiae documentum: et sicut vetus aetas vidit quid ultimum in libertate esset, ita nos quid in servitute, adempto per inquisitiones etiam loquendi audiendique commercio. Memoriam quoque ipsam cum voce perdidissemus, si tam in nostra potestate esset oblivisci quam tacere.

3. Nunc demum redit animus; sed quamquam primo statim beatissimi saeculi ortu Nerva Caesar res olim dissociabiles miscuerit, principatum ac libertatem, augeatque quotidie felicitatem temporum Nerva Trajanus, nec spem modo ac votum securitas publica, sed ipsius voti fiduciam ac robur adsumpserit, natura tamen infirmitatis humanae tardiora sunt remedia quam mala; et ut corpora nostra lente augescunt, cito extinguuntur, sic ingenia studiaque oppresseris facilius quam revocaveris: subit quippe etiam ipsius inertiae dulcedo, et invisa primo desidia postremo amatur. Quid? si per quindecim annos, grande mortalis aevi spatium, multi fortuitis casibus, promptissimus quisque saevitia principis interciderunt, pauci, ut ita dixerim, non modo aliorum sed etiam nostri superstites sumus, exemptis e media vita tot annis, quibus juvenes ad senectutem, senes prope ad ipsos exactae aetatis terminos per silentium venimus. Non tamen pigebit vel incondita ac rudi voce memoriam prioris servitutis ac testimonium praesentium bonorum composuisse. Hic interim liber honori Agricolae soceri mei destinatus, professione pietatis aut laudatus erit aut excusatus.

Birth and early years of Agricola.

4. Gnaeus Julius Agricola, vetere et inlustri Forojuliensium colonia ortus, utrumque avum procuratorem Caesarum habuit, quae equestris nobilitas est. Pater illi Julius Graecinus senatorii ordinis, studio eloquentiae sapientiaeque notus, iisque ipsis virtutibus iram Gaii Caesaris meritus: namque M. Silanum accusare jussus et, quia abnuerat, interfectus est. Mater, Julia Procilla, fuit, rarae castitatis. In hujus sinu indulgentiaque educatus per omnem honestarum artium cultum pueritiam adulescentiamque transegit. Arcebat eum ab inlecebris peccantium, praeter ipsius bonam integramque naturam, quod statim parvulus sedem ac magistram studiorum Massiliam habuit, locum Graeca comitate

et provinciali parsimonia mixtum ac bene compositum. Memoria teneo solitum ipsum narrare se prima in juventa studium philosophiae acrius, ultra quam concessum Romano ac senatori, hausisse, ni prudentia matris incensum ac flagrantem animum coërcuisset. Scilicet sublime et erectum ingenium pulchritudinem ac speciem magnae excelsaeque gloriae vehementius quam caute adpetebat. Mox mitigavit ratio et aetas, retinuitque, quod est difficillimum, ex sapientia modum.

NOTES TO TACITUS.

Chap. I.—The construction of the first sentence is a little obscure. *Tradere*, with its object, forms the object of the transitive verb *omisit*, while *usitatum* is in agreement with *tradere*. In translating you will find it in accord with the English idiom to break up the sentence into two.

Supergressa est. This is from the deponent verb *supergredior*, and upon it depends *vitium*, and the nouns in apposition with that word.

Sed apud priores. A little freedom must be exercised in translating this passage. A term such as "amongst our ancestors there was opportunity and a fair field for the performance of memorable deeds," best represents the meaning.

Ambitione. This word does not here mean *ambition*, in the sense in which that word is used in English. Its history is curious enough to merit notice. Literally, it signifies nothing more than "a going round." But it became a common political term, and meant "going round to ask people for their votes," or, as we should say, "canvassing." From this sense to "a desire to please," "vanity," or "ambition," the step is a short one. In the present passage you had better translate it "self-seeking."

Rutilio et Scauro. Rutilius and Scaurus were rival politicians in the days of the Republic. The former was consul in 105 B.C., the latter twice achieved the honour of the consulship in 115 B.C. and 107 B.C.

Citra fidem. "Falling short of," *i.e.*, "not obtaining belief."

Obtrectationi. This is the predicative dative.

Quam non petissem incursaturus. "Which I would not have asked had I been going to attack." *Incursaturus* is the future participle (= about to attack), but here it is equivalent to the protasis of a conditional sentence.

Chap. II.—*Saevitum.* Used impersonally: "fury was wreaked." The outrage here referred to took place in the reign of Domitian.

Comitio et foro. This is a legal formula, the *comitium* being itself a part of the *forum*.

Quid ultimum, etc. "How far liberty could go."

Ita nos. After *nos* supply *vidimus*.

Chap. III.—*Principatum.* That form of government which has a *princeps* or absolute ruler as its head: empire.

Nec = *et non*.

Ingenia studiaque. Messrs. Church and Brodripp admirably translate these words by "genius and its pursuits."

Quindecim annos. The fifteen years of Domitian's inauspicious reign, *i.e.*, A.D. 81 to 96.

Promptissimus quisque. This is equivalent to *promptissimi omnes*, and is therefore followed by a plural verb.

Non tamen pigebit. By this Tacitus means that he will not regret having told in his "Histories," the work which he was even *now* writing, the story of Domitian's reign.

Interim. The life of Agricola is regarded as an interlude in the composition of the greater work.

Soceri. Tacitus had married the daughter of Agricola in A.D. 78.

Chap. IV.—*Forojuliensium colonia.* Forum Julii, the modern Frejus.

Arcebat. The nominative to this verb is the clause introduced by *quod* and ending with *compositum*.

Massilia. Massilia, now Marseilles, was long the stronghold of Greek learning and culture. The description of Massilia as a place in which courtesy and provincial *economy* were happily combined is an excellent instance of the compression of Tacitus' style.

Ultra quam concessum Romano ac senatori. It is interesting to notice that though "a Roman and a Senator" might imbibe the culture of Massilia in moderation, there was a point in the pursuit of philosophy beyond which it was undignified to go.

Modum. This is σωφροσύνη, "moderation," or "restraint," the virtue which the Greeks reverenced beyond all others.

KEY TO TRANSLATION FROM VERGIL.—III. (p. 261)

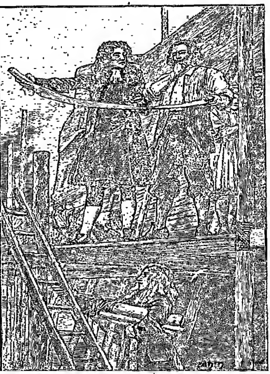
All were silent, and held their countenances in attention. Then from his high couch, father Æneas thus began:—"Too cruel to be told, O Queen, is the grief that you bid me renew—how the Danaans piteously overthrew the power of Troy and its empire; and (all) the deeds of misery which I saw myself, and the deeds in which I took a great part. Who, in telling of such things—who of the Myrmidons or the Dolopes, or what soldier of ruthless Ulixes, could refrain from tears? And now dewy night is falling over the sky, and the setting stars counsel slumber. But if you have so great a desire to learn of our downfall, and in brief words to hear the last suffering of Troy, though my mind shrinks from memory and starts back in anguish, I will attempt the task. Wearied in war and foiled by fate, the leaders of the Danaans—now that so many years were gliding away—build up a horse huge as a mountain, with the divine skill of Pallas (aiding them), and interlace its ribs with planks of fir. They pretend it is a vow for their (safe) return; this is the rumour that spreads abroad. In this they enclose secretly in its hollow sides certain picked heroes whom they chose, and fill closely the huge hollows of its womb with armed warriors . . . . The crowd is divided in uncertainty into opposing parties. Then first before the rest, with a great crowd in his train, Laocoon in fiery eagerness comes down from the top of the citadel, and while still far off (cries out): 'What great madness is this, O hapless citizens? Deem you that our enemies have sailed away? or think you that any gifts of the Danaans are free from guile? Is this your knowledge of Ulixes? Either the Achaeans are shut up and concealed within this mass of wood, or it is an engine framed against our walls, intended to spy on our houses and to come down on the city from above; or (else) there is some (other) secret guile. Trust not the horse, O Teucrians; whatever it be, I fear the Danaans, even though they bear (us) gifts.' So he spake, and with mighty strength he hurled a huge spear against the beast's side, and into the jointed arch of its belly. It lodged (and stayed) quivering; and as the womb shook again, the caverns sounded hollow, and gave forth a groan. And had the fates of the gods so willed it—had (men's) minds not been distraught, he had led us on to spoil with sword the Argives' lurking-place; and thou, Troy, wouldst now be standing, and thou, Priam's lofty citadel, wouldst (still) remain . . . . We

fled bloodless at the sight; the snakes with unswerving column make for Laocoon. And first each serpent grasps in its embrace and folds round the youthful bodies of his two sons, and devours their poor limbs. Afterwards, as the father himself comes up to aid, with weapons in his hand, they seize on him, and fetter him with their huge folds; and now, twice folded round his waist, twice spreading their scaly bodies round his neck, they tower above him with their heads and lofty necks. He all the while strains to pull asunder the knots with his hands; with his fillets stained with gore and black poison; and all the while raised terrible cries to the stars."

IV. (p. 263).

Alas, how blind are the minds of seers! What avail are vows—what avail temples, to one in the frenzy (of love)? All the time the flame consumes her soft heart, and beneath her breast the wound unconfessed is kept alive. She is on fire, the unhappy Dido, and in her madness wanders through the whole city, like a doe when the arrow has sped to its aim, whom unawares in Cretan groves a shepherd, chasing with his darts, has pierced from afar, and left the flying steel within the wound, though he knows it not; she in her flight ranges over the woods and lawns of Dicte. The deadly shaft clings to her side. Now she leads Æneas with her through the heart of the town, and shows to him the wealth of Sidon, and the city (almost) built. She begins to speak, and stops midway in her utterance; now, as day wanes, she seeks again the banquet of yesterday, and again in her madness asks to hear of the sufferings of Troy, and again hangs on his lips as he tells the tale. Afterwards, when all are gone, and the moon, shrouded in turn, quenches her light, and the setting stars invite slumber—she mourns alone in the empty hall, and lies on the deserted couch; herself far off, she sees and hears him far off; or (again) she clasps to her bosom Ascanius, fast bound by his father's likeness, (trying) if perchance she may beguile her speechless love. The towers begun rise no further; the youth no longer practise arms, or make ready havens and bulwarks for safety in war. The works are broken off and suspended—the mighty threatening walls and the engine, raised level with the sky . . . .

"Hast thou hoped that thou couldst even conceal so great a crime, and depart in silence from my land? And has our love—our troth once plighted—no hold on thee, nor Dido, whom thou doomest to die by a cruel death? Nay, art thou even fitting out thy fleet, with wintry star (against thee), and dost thou hasten to go over the deep in the midst of the north winds, hard-hearted one? What? If thou wert not seeking strange lands and an unknown home; if Troy of old were still standing, would Troy be sought by thy fleets across a billowy sea? Is it I from whom thou fleest? By these tears I shed, and by thy right hand, I (implore) thee, by our wedlock and our nuptial rights yet incomplete, if I have deserved well of thee, or thou hast found any joy in me, pity my house as I totter to my fall, and put off, I pray you—if there is still a time for prayers — that mind of thine. Why delay I (to die)? Is it till my brother Pygmalion overthrow my walls, or the Gaetulian Iarbas lead me away captive? If only any offspring of thine had been born to me before thy flight—if some tiny Æneas were playing in my hall, who still might remind me by his looks of thee—I should not verily feel utterly captive and forlorn."



PETER THE GREAT AT DEPTFORD.

HISTORIC SKETCHES, GENERAL.—X.

[*Continued from p. 268.*]

RUSSIA AND PETER THE GREAT.

In the year 1697, five years before the death of William III., a foreigner of singular personal appearance, of rough exterior, and still rougher

manners, applied to the English authorities to be allowed to work as a shipwright's labourer in one of the royal dockyards. Not only was permission granted for him to work as he wished at Deptford dockyard, but orders were given to the superintendent there to let the stranger see as much as possible of the shipbuilder's art, and to afford him every information he might desire. A good house (one that belonged to the Evelyn family, and in which John Evelyn, the accomplished diarist and author, wrote and studied) was taken for him and his companions at Deptford, so that he might live near his work, and in the dockyard he laboured early and late, and possessed himself to a remarkable extent with the knowledge of a skilled shipwright. This was not the only object he had in entering himself at the yard. He knew, none better, that example is worth a hundred precepts, and that he could appeal from those of his subjects who did not think it became them to work, to his own example, by which he had shown them both how to work and why they should work.

This shipwright and dockyard labourer was Peter the Great, Czar of Russia, who a few months before had quitted his capital, Moscow, to see and learn new things for his kingdom, of which the most important knowledge that he possessed was that it sadly needed reformation in every department. Resolved to bring his countrymen out of the barbarism in which they were immersed, and aware that this could only be done by the introduction of civilised elements from without—aware, too, of the superstitious horror the Russians had for either leaving their own country themselves or for allowing strangers to enter it—he conceived the idea of making a tour of the principal capitals of Europe, where he might learn for himself what was worthy to be introduced, and where he might enlist artificers and scientific men in his service to come to Russia and teach his subjects. At the same time he sent ambassadors to the several courts of Europe, that Russia might be represented, and that he might know from authentic sources what was going on in the world of politics. Amsterdam was the first city that arrested his attention, where the great amount of shipping, of which he was exceedingly fond, drew him with peculiar force. He worked in a dockyard there for some time, living like any other labourer, and refusing to allow any distinction to be made between him and his fellows. After acquiring all the knowledge he could pick up in Amsterdam, he came over to England.

Rough, even brutal in his manners—for what was he but the chief barbarian of his empire?—the Czar Peter had talents which were superlatively great, as compared with those of anyone else in his dominions. He had the wisdom to see wherein his people were wanting, and to recognise the means of supplying their wants; he had the magnanimity to disregard all the carping criticisms of those who, having been born in more civilised countries, affected to despise the wild men of the north; and he had the courage to persist in improving, in spite of themselves, a nation whose leaders hated to be reformed, and whose fears and superstitions whispered them to cling to the dead past rather than to draw life and energy from the living present. Rough manners, as indicative of a strong will, were perhaps essential to the fulfilment of Peter's purpose. A soft-speaking, gentle-handed man would never have curbed the hitherto unbridled licence of a savage soldiery, nor have overcome the pig-headed, unreasonable opposition of priests and landlords, who only saw in the enlightenment of the nation the downfall of their own power.

The Czar Alexis, grandfather of Peter the Great, was the first native prince who seems to have thought the Russians capable of being anything more than mere savages. Not until his succession to the throne had the empire sufficiently recovered from the repeated incursions of the Mongolian Tartars, of the Poles — who devastated whole districts, and kept possession of strong towns like Smolensko—and from the still more fatal wounds inflicted by civil war, to allow of attention being turned to the general amelioration of the empire. Hitherto the history of Russia consisted of accounts of savage life on a large scale, of the conflicts which one set of great chiefs waged with another, of the struggle for supremacy between the head of the State and the Church, and of the gradual absorption by the Czar of all actual power, which he held, nevertheless, as all despotic rulers must hold their power, by the good-will of the guards who are the ministers of their will. Alexis came to the throne in 1645, and soon proved to be the "still, strong man" who knew how to rule, not merely in the interests of his family, but in those of his people. He did something towards lessening the power of the soldiers, diminished that of the priesthood, and by protecting merchants who came from the southward and from Sweden with their wares, encouraged commerce and to a slight extent Russian manufacture. But he had a difficult task to perform—hard, unimpressionable stuff to work upon; and in consequence of the geographical position of Russia, and the extreme ignorance which prevailed in Europe as to its character and resources, he had little or no sympathy from without. For in that day Russia was to the other nations of Europe what Abyssinia is to them now,

a land little known save by bold adventurers, who, unable to get employment or living in the south, or actuated by curiosity and the love of adventure, travelled into the north, and either settled there and were no more heard of, or returned and related marvellous accounts of the people and countries which were included in the empire of the Czar of Muscovy, for so Russia was called. Occasionally there were state embassies sent from Moscow to some European court in order to make some special representation, and messengers from European courts occasionally made their way to Moscow to lay before the Czar some complaint against his border-subjects, which the Czar was commonly wholly unable to attend to. But the interchange of visits was very seldom, and there was not till the time of Peter the Great any regular representative of Russia in any capital in Europe.

Alexis did his best for his countrymen, and dying in 1676, was succeeded by his son Feodor, who entered fully into all his father's plans, and proceeded on his accession to the throne to develop the policy of improvement begun by the late Czar. "He lived the joy and delight of his people, and died amidst their sighs and tears. On the day of his decease Moscow was in the same state of distress which Rome felt at the death of Titus," wrote a Russian historian of this prince, who reigned six years, and dying, bequeathed his crown to his youngest child, Peter, a lad of no more than ten years of age. Ivan, Feodor's eldest son, was half-witted, and his sister Sophia, without authority from anyone, took the government upon herself, and during seven years did nearly as much to throw Russia back into barbarism as her father and grandfather had done to bring her out of it. Peter, who knew that the crown had been left to him, was angry, even as a child, at the usurpation of which he was the victim. He chafed at the restraints to which his sister and her ministers and advisers subjected him, and he saw with indignation as he grew older that the forward steps taken by his father were being deliberately retraced. Disgust for this policy probably heightened the spirit which descended to him from his father, the spirit of dislike for the old Muscovite party, undying hatred for those soul-numbing principles which hung as tremendous dead-weights on the nation and kept it back. Then there was something more than a hint that his sister and her favourite, a profligate barbarian, contemplated keeping him out of his inheritance. The people murmured at the gross misgovernment of the princess, and loudly demanded the termination of her rule. By means of large bribes to the soldiers, she succeeded for a while in maintaining her position by force; but when the means of bribery began to fail, and the conduct of the rulers became too bad even for the Russians to put up with, Peter, then in his seventeenth year, took advantage of the popular feeling to assert himself. He gained the co-operation of the soldiers, and of all the men of influence in the state, for even the heads of the old Muscovite section knew they could not have worse rulers than Sophia and her lover, and they hoped to mould the young prince, still a mere youth, into their own effete notions of government and public policy.

Peter assumed the reins of power, shut his sister up in a nunnery, and banished her lover to a distant part of the empire. Ivan Romanoff, Peter's brother, was nominally associated with him in the empire, but he had no real authority, so that virtually from the age of seventeen Peter was lord and autocrat of the Russian dominions.

As soon as he had reduced chaos into something like order at Moscow, Peter began that deadly war against the Turkish power which has burst out at intervals ever since, and which, if Russia works its will, will probably never know its final end till the cross shall have been again planted in Constantinople, and the Turkish power, which entered Europe in 1453, shall have been driven once more into Asia, whence it came out. Peter's enterprises against the Turks were very successful. He defeated them with troops inferior in discipline and armament to their own, and took from them the port of Azof, so opening the Black Sea to Russian commerce, and securing an outlet for Russian enterprise to the southward. Penetrated with the belief that commercial intercourse with other nations could alone enable Russia to become civilised, he conceived the plan of making a watery highway throughout his empire, from the Baltic to the Caspian and Black Seas, by means of canals which should unite the rivers Dwina, Volga, and Don. To secure the communication on the north-western side, and to obtain for Russia the command of the Baltic—perhaps, also, with the idea of more thoroughly breaking with the Russian past—he determined to build on an island in the Neva, a few miles above the place where that river falls into the Baltic, a city which should be at once the emporium of commerce for Northern Europe and the capital of the empire. For ten years these wars and these great national works occupied his attention, and then, in 1698, finding himself deficient in technical and material education, and that there was not anyone in his dominions who was capable of teaching him, he resolved to set out on his European tour of inspection and self-education.

In 1699 Peter returned home, with men of all

trades and professions in his train, who were to help him in his public works, and to teach his people the knowledge of other countries. Generals, military officers of all grades, engineers, shipwrights, architects, gunsmiths, cutlers, medical men, artificers and mechanics of all kinds, naval officers and experienced seamen, were gathered out of those countries which had specialities in them. Great Britain and Ireland, Holland, and the Netherlands furnished the greater part, but artists were allured from France and Italy, by the tempting offers of the Czar, to undertake a residence in the cold climate of the north.

Emboldened by his contact with civilisation, and disgusted from the same cause with much that he saw when he got home, Peter summarily abolished immediately after his return some of the most cherished and most barbarous institutions of the empire. He hanged some objectors who had been troublesome during his absence, and he refused to listen to the complaints of those, the priests included, who stood forward as the advocates of the old order. His will was supreme, and, being as strong and unyielding as that of the most obstinate man in his empire, carried all opposition before it; and the people, venerating him as the Czar, and ignorant of what new coercive power he might have brought with his other novelties from the south, gave in to him, and suffered him to tame them, even to shaving their beards—this reform almost cost a revolution — without resistance. General Gordon set to work upon the army, and succeeded, by dint of unremitting attention and the exercise of the utmost severity, in putting it into shape, though it required many a defeat from the hands of Swedes before it could be made at all confident in the presence of European enemies.

Scarcely was the army removed one degree from the class "rabble," ere occasion called for a display of its powers. In 1697 Charles XII. of Sweden came to his father's throne, and commenced that series of wars which astounded and convulsed Europe. Peter entered into alliances with the King of Denmark and the Elector Frederick Augustus of Saxony, who had been chosen King of Poland, and in 1700 the war began by the Danes invading the territory of the Duke of Holstein-Gottorp, the brother-in-law of the King of Sweden. Charles XII. appeared suddenly before Copenhagen, which he blockaded by sea and besieged by land, and he so pressed the Danes that their king was compelled to make peace on humiliating terms, and to leave his allies to their fate. From Copenhagen Charles went straight and swiftly to Narva, which was besieged by the Russians with 80,000 men. The Swedes numbered only 10,000, but Charles did not hesitate to attack the entrenched camp of the besiegers, which, after being breached by the Swedish artillery, was carried by storm at the point of the bayonet. Eighteen thousand Russians were killed and 30,000 were taken prisoners, and all the baggage and artillery fell into the victor's hands. "The Swedes will teach us how to conquer them," said Peter after the battle, and at once took steps for bringing another army into the field. Charles XII. continued on a long series of victories. Poles, Saxons, and Russians melted away before him; the King of Poland was dethroned at his dictation, and a nominee of his own raised in his stead; the Emperor of Germany had to concede certain things not by any means to his taste; and all Europe trembled when the King of Sweden marched. This went on from 1702 to 1706, and then the Czar, having a large army at his back, thought he might seek peace with honour. But Charles declared that he would not talk of peace until he reached Moscow, which he proposed to burn. Like another invader (Napoleon I.), he found the Russians prepared to do anything rather than see their capital in an enemy's hand. Peter devastated the country, harassed the march of the Swedes, cut off the discontented Cossacks, who were in secret alliance with Charles, and in other ways hindered his operations. Finally, at Poltava—which fortress, in the Ukraine, Charles was besieging—the Czar came up with his enemies; a bloody battle ensued, in which the most desperate valour was shown, but the Swedes were utterly routed—8,000 were slain and 18,000 captured. Charles was obliged to seek refuge in Turkey, where he employed himself in trying to promote the anger of the Turks against the Russians, but he was never thenceforth the thorn he had been in the side of the Czar.

Peter, freed from external troubles, again turned his attention to home affairs. St. Petersburg was finished, and the other great works were brought to a successful termination; vast strides were rapidly made in the improvement of all public institutions; and the Czar had the happiness before his death to find by many infallible signs that he was really looked upon as the father of his country.

The Russia which he left in 1725 was so radically altered in character from the Russia to which he had succeeded, that it could flourish and be prosperous under the hand of a woman, Peter's widow, who succeeded him as Catherine I. The height to which Catherine II. and successive emperors have raised it is matter rather of general history than for an historic sketch.

See:—Cassell's Universal History.

GREEK.—VI.

[Continued from p. 322.]

THE THIRD DECLENSION (continued)

I. NOUNS WHOSE STEM ENDS IN A CONSONANT (continued).

(iii.) Nouns whose stem ends in -ν or -ντ: *e.g.*, ἡ ῥίς, ῥιν-ός, *the nose*; ὁ δελφίς, δελφῖν-ος, *a dolphin*; ὁ γίγας, γίγαντ-ος, *a giant*; ὁ ὀδούς, ὀδόντ-ος, *a tooth* (Latin *dens*, English *dentist*).

Singular.

Nom.	ῥίς.	δελφίς.	γίγας.	ὀδούς.
Gen.	ῥιν-ός.	δελφῖν-ος.	γίγαντ-ος.	ὀδόντ-ος.
Dat.	ῥιν-ί.	δελφῖν-ι.	γίγαντ-ι.	ὀδόντ-ι.
Acc.	ῥῖν-α.	δελφῖν-α.	γίγαντ-α.	ὀδόντ-α.
Voc.	ῥίς.	δελφίς.	γίγαν.	ὀδούς.

Plural.

Nom.	ῥῖν-ες.	δελφῖν-ες.	γίγαντ-ες.	ὀδόντ-ες.
Gen.	ῥιν-ῶν.	δελφίν-ων.	γιγάντ-ων.	ὀδόντ-ων.
Dat.	ῥι-σί.	δελφῖ-σι.	γίγα-σι.	ὀδοῦ-σι.
Acc.	ῥῖν-ας.	δελφῖν-ας.	γίγαντ-ας.	ὀδόντ-ας.
Voc.	ῥῖν-ες.	δελφῖν-ες.	γίγαντ-ες.	ὀδόντ-ες.

Dual.

N.A.V.	ῥῖν-ε.	δελφῖν-ε.	γίγαντ-ε.	ὀδόντ-ε.
G.D.	ῥιν-οῖν.	δελφίν-οιν.	γιγάντ-οιν.	ὀδόντ-οιν.

To this class belong the following adjectives:—

(1) In -ας, -αινα, -αν, as μέλας, μέλαινα, μέλαν (gen. μέλανος, μελαίνης, μέλανος), *black*; and τάλας, τάλαινα, τάλαν, *unhappy*.

(2) Πᾶς, πᾶσα, πᾶν (gen. παντός, πάσης, παντός), *all*, *every*; and its compound ἅπας, ἅπασα, ἅπαν.

(3) Ἑκών, ἑκοῦσα, ἑκόν (gen. ἑκόντος, ἑκούσης, ἑκόντος), *willing*; and ἄκων, ἄκουσα, ἆκον, *unwilling* (ἀ *privative* making ἑκών into ἄκων).

(4) The adjectives in -εις, -εσσα, -εν. For example, χαρίεις, χαρίεσσα, χαρίεν, *lovely*, which have in the dative plural of the masculine and neuter gender -εσι (instead of -εισι, as it is in λειφθείς, *left behind*; for the *participles* in- εις, -εισα, -εν, form the case regularly in -εισι).

Singular.

	Masculine.	Feminine.	Neuter.
Nom.	ὁ χαρίεις	ἡ χαρίεσσα	τὸ χαρίεν.
Gen.	χαρίεντος	χαριέσσης	χαρίεντος.
Dat.	χαρίεντι	χαριέσσῃ	χαρίεντι.
Acc.	χαρίεντα	χαρίεσσαν	χαρίεν.
Voc.	χαρίεν	χαρίεσσα	χαρίεν.

Plural.

Nom.	χαρίεντες	χαρίεσσαι	χαρίεντα.
Gen.	χαριέντων	χαριεσσῶν	χαριέντων.
Dat.	χαρίεσι	χαριέσσαις	χαρίεσι.
Acc.	χαρίεντας	χαριέσσας	χαρίεντα.
Voc.	χαρίεντες	χαρίεσσαι	χαρίεντα.

Dual.

N.A.V.	χαρίεντε	χαριέσσα	χαρίεντε.
G.D.	χαριέντοιν	χαριέσσαιν	χαριέντοιν.

Singular.

Nom.	ὁ λειφθείς	ἡ λειφθεῖσα	τὸ λειφθέν.
Gen.	λειφθέντος	λειφθείσης	λειφθέντος.
Dat.	λειφθέντι	λειφθείσῃ	λειφθέντι.
Acc.	λειφθέντα	λειφθεῖσαν	λειφθέν.
Voc.	λειφθείς	λειφθεῖσα	λειφθέν.

Plural.

Nom.	λειφθέντες	λειφθεῖσαι	λειφθέντα.
Gen.	λειφθέντων	λειφθεισῶν	λειφθέντων.
Dat.	λειφθεῖσι	λειφθείσαις	λειφθεῖσι.
Acc	λειφθέντας	λειφθείσας	λειφθέντα.
Voc.	λειφθέντες	λειφθεῖσαι	λειφθέντα.

Dual.

N.A.V.	λειφθέντε	λειφθείσα	λειφθέντε.
G.D.	λειφθέντοιν	λειφθείσαιν	λειφθέντοιν.

VOCABULARY.

Ἀκτίς, -ῖνος, ἡ, a beam, ray.
Αὐτός, he himself (Latin *ipse*): ὁ αὐτός, the same (Latin *idem*).
Βρῶμα, -ατος, τό, food.
Ἐλέφας, -αντος, ὁ, an elephant, ivory.
Εὔπορος, -ον (with gen.), easily passed, abounding.
Ἥλιος, -ου, ὁ, the sun.
Κωτίλος, -η, -ον, loquacious.
Λεαίνω, I make smooth, polish, masticate.
Λιβύη, -ης, ἡ, Lybia, Africa.
Μάχη, -ης, ἡ, fight, battle.
Ὀσφραίνομαι (gen.), I smell something.
Ποτέ, once (an enclitic)
Φιλάνθρωπος, man-loving philanthropic.
Χώρα, -ας, ἡ, country, district.

EXERCISE 27.

Translate into English:—

1. Οὐ πᾶσιν ἀνθρώποις ὁ αὐτὸς νοῦς ἐστιν. 2. Τοῖς ὀδοῦσι τὰ βρώματα λεαίνομεν. 3. Οἱ δελφῖνες φιλάνθρωποί εἰσιν. 4. Ἔστιν* ἀνδρὸς ἀγαθοῦ πάντα κακὰ ἀνδρείως φέρειν. 5. Πολλαὶ Λιβύης χῶραι εὔποροί εἰσιν ἐλέφαντος. 6. Πάντες κωτίλον ἄνθρωπον ἐχθαίρουσιν. 7. Τοῖς γίγασί ποτε ἦν μάχη πρὸς τοὺς θεούς. 8. Ταῖς τοῦ ἡλίου ἀκτῖσι χαίρομεν. 9. Ῥινῶν ἔργον ἐστὶν ὀσφραίνεσθαι.

EXERCISE 28.

Translate into Greek.—

1. We have ivory 2. Ivory is produced (γίγνομαι) in districts of Africa. 3. The rays of the sun delight the shepherds. 4. The brothers and the sisters are delighted by the rays of the sun. 5. The sister is lovely. 6. We admire fine ivory. 7. There are many elephants in Africa. 8 The business of the teeth is to masticate the food. 9. It is the duty of every man to worship the divinity. 10. The gods once had a war with the giants.

* The verb ἐστί with a genitive, as here, signifies "it is the duty of," "it is becoming in."

According to ὀδούς are formed words componnded with ὀδούς: as, ὁ, ἡ μονοδούς (gen μονοδόντος), *having one tooth.* According to γίγας, adjectives in -ας (gen. -αντος): as, ὁ, ἡ ἀκάμας, *unsubdued, unwearied.*

(iv.) Neuter nouns whose stem ends in -τ and -κτ: as, γάλα, *milk*, γάλακτ-ος, *of milk.* As the laws of euphony do not endure a τ or κτ at the end of a word, the τ and the κτ disappear in the nominative, or pass (as in οὖς, gen. ὠτός, *an ear*) into ς. Thus, τὸ σῶμα, σώμᾰτος, *a body*; τὸ γόνυ, γόνᾰτος, *a knee*; τὸ γάλα, γάλακτος, *milk*; and τὸ οὖς, ὠτός, *an ear* are declined as follows:—

Singular.

N.V.A.	σῶμα.	γόνυ.	γάλα.	οὖς.
Gen.	σώμᾰτ-ος.	γόνᾰτ-ος.	γάλακτ-ος.	ὠτ-ός.
Dat.	σώμᾰτ-ι.	γόνᾰτ-ι.	γάλακτ-ι.	ὠτ-ί.

Plural.

N.V.A.	σώμᾰτ-α.	γόνᾰτ-α.	γάλακτ-α.	ὦτ-α.
Gen.	σωμάτ-ων.	γονάτ-ων.	γαλάκτ-ων.	ὤτ-ων.
Dat.	σώμᾰ-σι.*	γόνᾰ-σι.*	γάλαξ-ι.*	ὠ-σί.*

Dual.

N.V.A.	σώμᾰτ-ε.	γόνᾰτ-ε.	γάλακτ-ε.	ὦτ-ε.
G.D.	σωμάτ-οιν.	γονάτ-οιν.	γαλάκτ-οιν.	ὤτ-οιν.

Note irregularities of accentuation in οὖς (genitive and dative dual and genitive plural paroxytone).

Like γόνυ (stem γονατ-), decline τὸ δόρυ, *a spear*, δόρᾰτος, δόρᾰτι, etc.; dative plural, δόρᾰσι.

VOCABULARY.

Ἁμάρτημα, -ᾰτος, τὸ, a failing, a fault, sin.
Ἅπτομαι, I hang on something, I touch.
Βαστάζω, I bear, carry.
Βοήθημα, -ᾰτος, το, help.
Γεύομαι, I taste.
Γυμνάζω, I exercise.
Διαμείβομαι, I exchange.
Ἐθίζω, I accustom.
Θεραπεία, -ας, ἡ, care, service.
Ἱδρως, ἵδρωτος, ὁ, sweat.
Ἱκέτης, -ου, ὁ, an entreater, petitioner.
Μικρός, -ά, -όν, small.
Μῦθος, -ου, ὁ, a speech, word.
Νύμφη, -ης, ἡ, a nymph.
Ποικίλος, -η, -ον, various, variegated.
Πρᾶγμα, -ᾰτος, το, a deed, thing.
Ῥῆμα, ῥήμᾰτος, a thing spoken, a word.
Σπένδω, I pour out, make a libation.
Σπεύδω, I hasten.
Ταυτολογία, -ας, ἡ, saying the same thing again, repetition.
Φαῦλος, -η, -ον, radically bad.
Χρῆμα, -ᾰτος, το, a thing for use; in the plural, goods, property.
Χρηστός, -ή, -ον, useful; good.
Χωρισμός, -ου, ὁ, a separation.

* For σώματσι, γόνατσι, γάλακτσι, ὠτσί.

EXERCISE 29.

Translate into English:—

1. Ἐν χαλεποῖς πράγμασιν ὀλίγοι ἑταῖροι πιστοί εἰσιν. 2. Οἱ ἱκέται τῶν γονάτων ἅπτονται. 3. Ὁ θάνατός ἐστι χωρισμὸς τῆς ψύχης καὶ τοῦ σώματος. 4. Ὁ πλουτὸς παρέχει τοῖς ἀνθρώποις ποικίλα βοηθήματα. 5. Μὴ πείθου κακῶν ἀνθρώπων ῥήμασιν. 6. Μὴ δούλευε, ὦ παῖ, τῇ τοῦ σώματος θεραπείᾳ. 7. Οἱ Ἕλληνες ταῖς νύμφαις κρατῆρας γάλακτος σπένδουσιν. 8. Ἔθιζε καὶ γύμναζε τὸ σῶμα πόνοις καὶ ἵδρωτι. 9. Οἱ ἀδολέσχαι τείρουσι τὰ ὦτα ταῖς ταυτολογίαις. 10. Τὴν ψύχην ἔθιζε, ὦ παῖ, πρὸς τὰ χρηστὰ πράγματα. 11. Οἱ φαῦλοι μῦθοι τῶν ὤτων οὐχ ἅπτονται. 12. Τοῖς ὠσὶν ἀκούομεν. 13. Μὴ ἔχθαιρε φίλον μικροῦ ἁμαρτήματος ἕνεκα. 14. Γεύου, ὦ παῖ, τοῦ γάλακτος. 15. Οἱ στρατιῶται δόρατα βαστάζουσιν.

EXERCISE 30.

Translate into Greek:—

1. O young men, exercise your (the) bodies with labour and sweat. 2. We strive after good deeds. 3. Many men delight in gold. 4. From a good deed arises glory. 5. We admire the good words of the wise. 6. The good deeds of good men are admired. 7. The soldiers fight with (dat.) spears. 8. I do not exchange the wealth of virtne for (dat.) kings. 9. Obey ye not the words of the bad.

II. NOUNS WHOSE STEM ENDS IN -σ.

We must now direct our attention to nouns whose stem ends in -σ. The nominative presents either (1) the pure stem, or (2) the stem with vowel modification—*e.g.*, lengthening of the last syllable or change of ε to ο. We must carefully note *that the σ of the stem* remains at the end and before a consonant, but disappears in the middle between two vowels.* In the dative plural one σ disappears, when the case-suffixes are added.

(i.) Of these words, let us consider, first those nouns the nominative of which ends in -ης, -ες. The terminations -ης (m. and f.), -ες (n.), belong only to adjectives, and to proper names terminating in adjectival forms in -νης, -λης, -γενης, -κρατης, -μηδης, -πειθης, -σθενης, and (-κλεης) -κλῆς. (*N.B.*—The neuter presents the pure stem.)

The words of this class suffer contraction after dropping the σ in all the cases, except the nominative and vocative singular, and the dative plural. The words ending in -κλέης being contracted into -κλῆς, again undergo contraction in the dative singular. Learn both the contracted and the uncontracted forms we are about to give of ὁ, ἡ σαφής, *clear*, τὸ σαφές; and ἡ τριήρης, *a trireme* (or galley with three banks of rowers).

* Σ between two vowels is always lost in Greek, just as in Latin it passes to r. So stem *genes* gives: Greek, genitive γένεσ-ος, γένε-ος, γένους; Latin, genitive *genes-is*, *gener-is*.

Singular.

Nom.	ὁ, ἡ σαφής.	τὸ σαφές.
Gen.	(σαφέος) σαφοῦς.	
Dat.	(σαφέ-ι) σαφεῖ.	
Acc.	(σαφέ-α) σαφῆ,	σαφές.
Voc.	σαφές.	σαφές.

Plural.

Nom.	(σαφέ-ες) σαφεῖς.	(σαφέα) σαφῆ.
Gen.	(σαφέ-ων) σαφῶν.	
Dat	σαφέσι.	
Acc.	(σαφέ-ας) σαφεῖς.	(σαφέ-α) σαφῆ.
Voc.	(σαφέ-ες) σαφεῖς.	(σαφέ-α) σαφῆ.

Dual

N.A.V.	σαφέ-ε, σαφῆ.
G.D.	σαφέ-οιν, σαφοῖν.

	Singular.	*Plural*
Nom.	ἡ τριήρης.	(τριήρε-ες) τριήρεις.
Gen.	(τριήρε-ος) τριήρους.	τριηρέ-ων and τριήρων.
Dat.	(τριήρε-ι) τριήρει.	τριήρε-σι.
Acc.	(τριήρε-α) τριήρη.	(τριήρε-ας) τριήρεις.
Voc.	τριῆρες.	(τριήρε-ες) τριήρεις.

Dual.

N.A.V.	τριήρε-ε and τριήρη.
G.D.	τριηρέ-οιν and τριήροιν.

(Note recessive accent in genitive singular, dative dual, and genitive plural.)

We subjoin the declension of the proper names Σωκράτης, *Socrates*, and Περικλέης, *Pericles* (like the singular of τριήρης, so Δημοσθένης). As strictly proper names, they are found only in the singular:—

Nom.	Σωκράτης.	(Περικλέης)	Περικλῆς.
Gen.	Σωκράτους.	(Περικλέε-ος)	Περικλέους.
Dat.	Σωκράτει.	(Περικλέε-ϊ)	(Περικλέει) Περικλεῖ.
Acc.	Σωκράτη.	(Περικλέε-α)	Περικλέᾱ.
Voc.	Σώκρατες.	(Περίκλεες)	Περίκλεις.

Mark the contraction in the dual of τριήρεε into τριήρη (not into the usual form in -ει), and the double contraction of the dative of Περικλέης.

In adjectives in -ης, -ες, when these terminations are preceded by a vowel, εα is commonly contracted into ᾱ, as in the proper noun Περικλέᾱ (and not into η, as in σαφέα, σαφῆ). For example, ἀκλεής, *unrenowned*, makes ἀκλεέα into ἀκλεᾶ in the masculine and feminine accusative singular, and in the neuter nominative, accusative, and vocative; so ὑγιής forms ὑγιᾶ.

Proper names of this termination—as well as Ἄρης, *Mars*, in the accusative singular—follow the first as well as the third declension, and are therefore denominated *heteroclite* (that is, *of different declensions*); accordingly we have both Σωκράτη and Σωκράτην. But in those ending in -κλῆς, the accusative in -ην is not found in Attic Greek.

VOCABULARY.

Αἰσχρός, -ά, -όν, shameful.
Ἀκρατής, -ές, immoderate.
Ἀληθής, -ές, true, honest.
Ἀναξαγόρας, -ου, ὁ, Anaxagoras.
Ἀτυχής, -ές, unfortunate.
Ἀφανής, -ές, unknown, unseen.
Δουλεία, -ας, ἡ, slavery, servitude.
Ἐλεαίρω, I pity.
Ἑλώδης, -ες, marshy.
Ἐπαμεινώνδας, -ου, ὁ, Epaminondas.
Ἡρακλῆς, -έους, ὁ, Hercules.
Ἰνδική, ἡ, India.
Κάλαμος, -ου, ὁ, a reed.
Ὁμιλία, ἡ, intercourse (with dat.).
Πόταμος, -ου, ὁ, a river.
Σοφιστής, -οῦ, ὁ, a sophist.
Σοφοκλῆς, -έους, ὁ, Sophocles.
Σωτηρία, -ας, ἡ, salvation.
Τόπος, -ου, ὁ, a place.
Τραγῳδία, -ας, ἡ, tragedy.

EXERCISE 31.

Translate into English.—

1. Αἱ Σοφοκλέους τραγῳδίαι καλαί εἰσιν. 2. Τὸν Σωκράτη ἐπὶ τῇ σοφίᾳ θαυμάζομεν. 3. Σωκράτει πολλοὶ μαθηταί εἰσιν. 4. Ἡ Ἰνδικὴ παρά τε τοὺς ποτάμους καὶ τοὺς ἑλώδεις τόπους φέρει καλάμους πολλούς. 5. Λέγε ἀεὶ τὰ ἀληθῆ, ὦ παῖ. 6. Ἀναξαγόρας, ὁ σοφιστής, διδάσκαλος ἦν Περικλέους. 7. Ὦ Ἡρακλεῖς, τοῖς ἀτυχέσι σωτηρίαν παρέχε. 8. Ἐπαμεινώνδας πατρὸς ἦν ἀφανοῦς. 9. Ἐλέαιρε τὸν ἀτυχῆ ἄνθρωπον. 10. Ὀρέγεσθε, ὦ νεανία, ἀληθῶν λόγων. 11. Οἱ ἀκρατεῖς αἰσχρὰν δουλείαν δουλεύουσιν.

EXERCISE 32.

Translate into Greek.—

1. Socrates had (in Greek, *to Socrates was*) wonderful wisdom. 2. Pity unfortunate men. 3. We pity unfortunate men. 4. Many youths were disciples of Socrates. 5. Socrates had (in Greek, *to Socrates was*) much wisdom. 6. They admire the wisdom of Socrates. 7. The immoderate (man) serves a shameful servitude. 8. We admire the beautiful tragedies of Sophocles. 9. True words are believed. 10. I pity the life of immoderate men. 11. Have not intercourse with immoderate men.

(ii.) Neuter nouns in -ος (gen. -εος, contracted into -ους). The substantives of this class are exclusively neuter, and the terminating σ belongs to the stem. In the nominative, the stem-vowel ε has passed into ο; for example, τὸ γένος (Latin *genus*), *race* (stem γενεσ); τὸ κλέος, *fame, glory* (stem κλεεσ).

Singular.

N.A.V.	γένος.	κλέος.
Gen.	(γένε-ος) γένους.	(κλέε-ος) κλέους.
Dat.	(γένε-ϊ) γένει.	(κλέε-ϊ) κλέ-ει.

Plural.

N.A.V.	(γένε-α) γένη.	(κλέε-α) κλέā.
Gen.	(γενέ-ων) γενῶν.	(κλεέ-ων) κλεῶν.
Dat.	γένε-σι.	κλέε-σι.

Dual.

N.A.V.	(γένε-ε) γένη.	(κλέε-ε) κλέη.
G.D.	(γενέ-οιν) γενοῖν.	(κλεέ-οιν) κλεοῖν.

VOCABULARY.

Ἀλλά, but.
Ἄνθος, το, a flower.
Ἀσφαλής, -ες, firm, sure.
Γῆ, γῆς, ἡ, the earth.
Ἔαρ (ἔαρος) ἦρος, τό, the spring.
Εἶδος, τό, a form.
Ζημία, -ας, ἡ, disgrace, punishment.
Θάλπος, το, warmth.
Θνητός, -ή, -όν, mortal, deadly.
Κέρδος, το, gain (in the plural).
Κλέος, τό, fame, glory; in the plural, honourable deeds.
Κρίνω (Latin *cerno*), I separate, decide, judge.
Μῆκος, τό, length.
Πονηρός, -α, -ον, wicked.
Ὕψος, τό, height.
Χαλκός, -οῦ, ὁ, brass.
Ψεῦδος, τό, a lie.
Ψῦχος, τό, cold.

EXERCISE 33.

Translate into English:—

1. Ἡ γῆ καλοῖς ἄνθεσιν θάλλει. 2. Μὴ ἀπέχου ψύχους καὶ θάλπους. 3. Τὸ καλὸν οὐ μήκει χρόνου κρίνομεν ἀλλὰ ἀρετῇ. 4. Οὐκ ἀσφαλὲς πᾶν ὕψος ἐν θνητῷ γένει [understand ἐστίν]. 5. Μὴ ψεύδη λέγε: 6. Ἀπεχόμεθα πονηρῶν κέρδων. 7. Κέρδη πονηρὰ ζημίαν ἀεὶ φέρει. 8. Κάτοπτρον εἴδους χαλκός, οἶνος δὲ νοῦ [understand ἐστίν]. 9. Οἱ ἄνθρωποι κλέους ὀρέγονται. 10. Οἱ ἄνδρες κλέει χαίρουσιν. 11. Οἱ ἀνδρεῖοι κλεῶν ὀρέγονται. 12. Θαυμάζομεν τὰ τῶν ἀνδρῶν κλέα.

EXERCISE 34.

Translate into Greek:—

1. He keeps (abstains) from wicked gains. 2. Good men keep from wicked gains. 3. Good men desire honourable deeds. 4. Do not, O young man, keep from heat and cold, but from wicked men. 5. Punishment follows a lie. 6. We admire the Greeks on account of their (the) honourable deeds. 7. We avoid wicked gains. 8. The soldiers rejoice in honourable deeds (dat.).

KEY TO EXERCISES.

Ex. 19.—1. Pay respect to the old man. 2. Worship the divinities. 3. Shepherds guard flocks. 4. Avoid the bad man as a perilous harbour. 5. Without the divinity man is not happy. 6. God dwells in the upper air. 7. Often severe cares waste away the minds of men. 8. Follow good leaders, O beloved (O friend). 9. O young man, give place to the aged. 10. Often the people have an unjust disposition as (their) leader. 11. God is the punisher of those who are too high-minded. 12. Have a sound mind. 13. O God, bestow good fortune on old men. 14. Huntsmen capture lions.

Ex. 20.—1. Οἱ ἀγαθοὶ παῖδες τοὺς γέροντας θεραπεύουσι. 2. Οἱ γέροντες θεραπεύονται ὑπὸ τῶν ἀγαθῶν παίδων. 3. Οἱ σώφρονες νεανίαι εἴκουσι τῆς ὁδοῦ τοῖς γέρουσι. 4. Ἕπεσθε, ὦ φίλοι, ἀγαθῷ ἡγεμόνι. 5. Ἔχομεν ἀγαθοὺς ἡγεμόνας. 6. Ὁ λεὼς πολλάκις ἕπεται κακοῖς ἡγεμόσι. 7. Ὁ Θεὸς παρέχει εὐτυχίαν τοῖς σώφροσι. 8. Οἱ λέοντες θηρεύονται ὑπὸ τῶν θηρευτῶν. 9. Το Θεῖον σεβόμεθα.

Ex. 21.—1. Love your father and your mother. 2. Be not thou a slave to the belly. 3. Rejoice, O dear youth, in thy good father and thy good mother. 4. Consult not with a bad man. 5. There were many beautiful temples to (in honour of) Demeter (Ceres). 6 The good daughter willingly obeys her dear mother. 7. Good men are admired. 8. Often a bad son is born of a good father. 9. I hate the bad man. 10. Shining glory follows good men. 11. Persephone (Proserpine) was the daughter of Demeter (Ceres) 12. O dear daughter, love thy mother. 13. Virtue is an honourable prize for a wise (skilful) man. 14. Good sons love their fathers and their mothers. 15. The Greeks worship Demeter. 16 O dear youths, obey your fathers and your mothers. 17. O dear father, gratify thy beloved daughter.

Ex. 22.—1. Ὦ νεανίαι, στέργετε τὸν πατέρα καὶ τὴν μητέρα. 2. Αἱ ἀγαθαὶ θυγατέρες τοῖς πατράσι καὶ ταῖς μητράσι πείθονται. 3. Οἱ πολῖται τὴν Δημητέρα σέβονται. 4. Τῇ Δημητρὶ ἕπεται ἡ Περσεφόνη 5. Τον ἀστέρα θαυμάζομεν. 6. Ὦ θηρευταί, μη δουλεύετε τῇ γαστρί. 7. Ἀγαθὴ μήτηρ ἀγαθὴν θυγατέρα στέργει. 8. Ὦ μῆτερ καὶ πάτερ, στέργετε τοὺς παῖδας. 9. Ὁ ἀνὴρ ἐχθαίρεται. 10. Τὸν ἄνδρα ἐχθαίρουσι. 11. Τοῖς σοφοῖς ἀνδράσι πείθονται. 12. Τῇ Δημητρὶ ἕπομαι. 13. Πολλάκις ἐξ ἀγαθοῦ πατρὸς καὶ μητρὸς γίγνονται κακοὶ υἱοι.

Ex. 23.—1. The ravens croak. 2. Avoid flatterers. 3. Keep away from the deceiver. 4. Men delight in the harp, in the dance, and in song. 5. Horses are driven by whips. 6. The harps delight the minds of men. 7. A grasshopper is friendly to a grasshopper, and an ant to an ant. 8. The shepherds sing to the accompaniment of their pipes. 9. Among the Athenians there were contests between quails and cocks. 10. The shepherds drive the flocks of goats into the meadows. 11 The life of ants and quails is very laborious. 12. Many have a good countenance, but a bad voice.

Ex. 24.—1. Φεύγω κόλακα. 2. Κόρακες κρώζουσι. 3. Τέρπεσθε φόρμιγγι. 4. Ὀρχηθμοὶ τοὺς ἀνθρώπους τέρπουσι. 5. Ἐλαύνουσι τοὺς ἵππους μάστιγξι. 6. Οἱ θυμοὶ τῶν ἀνθρώπων ἐλαύνονται φόρμιγγι. 7. Αἱ σύριγγες τέρπουσι τοὺς ποιμένας. 8. Αἱ αἶγες εἰς τὸν λειμῶνα ἐλαύνονται. 9. Ὁ ποιμὴν ᾄδει ὑπὸ τῆς σύριγγος. 10. Καλὴν μὲν ὦπα ἔχει ἡ θυγάτηρ, κακὴν δὲ ὄπα.

Ex. 25.—1. The birds sing. 2. Favour begets favour, (and) strife (begets) strife. 3. We count youth happy. 4. Need begets strife. 5. Rich men often conceal their baseness by (means of) wealth. 6. O fair boy, love your good brother and your fair sister. 7. Avarice is the mother of every kind of baseness. 8. The poor are often happy. 9. Wisdom in the hearts of men stirs up marvellous longings for the beautiful. 10. Death sets men free from their cares. 11. Friendship springs up by means of resemblance (in disposition). 12. Wine creates laughter 13. Deliberation comes to the wise in the night. 14. The wise punish baseness. 15. Men often delight themselves with light (or vain) hopes

Ex. 26.—1. Ὄρνιθες ᾄδουσι. 2. Χάρις χάριν τίκτει, ἔρις ἔριν. 3. Σοφίᾳ ἐγείρεται ἐν τοῖς τῶν ἀνθρώπων θυμοῖς θαυμαστὸς ἔρως ἀγαθῶν. 4. Τέρπομαι τῇ ᾠδῇ τῶν ὀρνίθων. 5. Αἱ ᾠδαὶ τῶν ὀρνίθων τέρπουσι τὸν ποιμένα. 6. Τερπόμεθα ὄρνισι. 7. Οἱ ἄνθρωποι ἕπονται τοῖς ἄναξι. 8. Οἱ ἄνθρωποι πείθονται τῷ νικητῇ

APPLIED MECHANICS—I.

INTRODUCTION—CLASSIFICATION OF QUANTITIES—HOW TO OBTAIN THE SUM OF CERTAIN QUANTITIES—EXPERIMENTAL ILLUSTRATIONS—NUMERICAL EXAMPLES.

THESE lessons are intended to give the beginner, who has some knowledge of arithmetic and who understands algebraic symbols, such a working knowledge of practical mechanics as shall enable him to solve ordinary problems in this subject which may present themselves in actual work. It is usual to commence lessons like the present by a number of definitions. The utility of such a course is doubtful. If, for example, you ask the intelligent beginner what he understands by *force*, he will probably answer a *push*, or a *pull*, and his conception is much simpler than that given by any definition, however exact. It will not simplify matters to tell him that force is that which *moves or tends to move matter*, hence that which produces *motion* or *strain*. This and other definitions will be of more service later on, when he has gained a certain knowledge of the quantities involved. We shall therefore not trouble the reader with many definitions just at present.

Mechanics, we are told, is the subject which deals with force as applied to material bodies. If the forces are balanced, their consideration belongs to that branch of mechanics called *Statics*, whilst, on the other hand, *Dynamics* treats of forces applied in such a way as to produce or alter motion. *Kinematics*, which deals with *motion* simply, is often included under the general head "mechanics." *Applied Mechanics* deals with the application of the laws of mechanics to the problems connected with force and motion which occur in the work of everyday life. It is generally intended to serve as an introduction to the science of engineering.

Problems connected with work or energy form a conspicuous feature in the modern developments of the subject.

There are three helps to the study of this subject none of which the student can afford to neglect: these are—first, reading good practical books, or listening to lectures; second, working good practical numerical examples; and third, carrying out carefully and thoughtfully quantitative experiments in connection with the subject. We hope in this article not only to give the first two, but to indicate the methods by which the third aid may be invoked.

Experience, both as a student and a teacher, convinces us that one might as well attempt to become a skilled workman at any trade by merely reading a description of the tools employed, as to try to get a working knowledge of a subject like this by mere reading, or listening to lectures, so we shall try to give such examples as shall have a *practical* bearing, and at the same time illustrate each important principle as it occurs; hence, if you wish to benefit by the lessons, *do not neglect the examples.* If any point seems a little difficult at first, remember that it is only by mastering something hitherto unknown or misunderstood that you can add to your stock of useful knowledge. The student of a subject like this is expected to know enough arithmetic to enable him to multiply and divide, and to understand the ordinary symbols of algebra. Read the lessons carefully, try to carry out the experiments indicated even if your apparatus be rough, work out every numerical example set, and you will have obtained a useful knowledge of the subject by the time you reach the last lesson.

The quantities we have to deal with in mechanics may be, for the present purpose at any rate, divided into two classes, *scalar* quantities and *vector* quantities. A *scalar* quantity has magnitude *only*, and requires for its complete specification only a number and a unit—it is in fact a simple *numeric*. A sum of money, for instance, is such a quantity, and we express its amount in terms of such a unit as one pound or one shilling. It is evident that we require *both* the number and unit, for if we say a man has *twenty* we convey no meaning, whereas if we say he is possessed of *twenty pounds* a definite idea is conveyed. The number *twenty* and the unit *one pound* are both required.

A *vector* quantity is not quite so simple. For instance, if we say, a body has a velocity of twenty feet per second, we have only specified *one* constituent of the motion—viz., its *magnitude*. We have not said anything as to the *direction* of the motion. Even if we specified that the velocity is along a given line, that is not sufficient, for we must also say which *way* the motion takes place along the line, as from south to north, or from north to south. This quantity velocity, therefore, has three constituents: viz., *magnitude*, *direction*, and *sense*, meaning by the latter term what has just been referred to. A straight line will represent such a quantity completely, the length of the line representing the *magnitude* of the quantity, the direction of the line the *direction* of the quantity, and an arrow-head on the line, the third and last constituent required—namely, *sense*. Such quantities are called *vector* quantities from the fact that they can be represented by straight lines.

It is true that we have to deal with some quantities which do not appear to belong to either of these two classes, and the student will find as he advances in his study of the subject that a further subdivision may be necessary. This general classification will, however, be found useful.

The following are a few instances of the two kinds of quantities:—

Scalar Quantities.	*Vector Quantities.*
A sum of money. A certain volume of any given material. Energy.	Velocity. Acceleration. Flow of a fluid. Stress and strain. Forces acting at a given point.

This illustration will be sufficient for the present.

THE SUMMATION OF VECTOR QUANTITIES.

The addition or summation of scalar quantities is a very simple matter, involving only the addition of numbers. The summation of vector quantities, on the other hand, is somewhat more complicated. Thus if two forces respectively of 15 and 20 units act at a point as shown by the lines O B and O A, Fig. 1, it is quite evident that their sum is *not* 35 units. If, however, the lines O B and O A *represent* the forces in the way already indicated, then

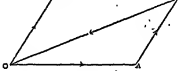


Fig. I.

if a parallelogram be constructed on these lines, the diagonal O C of the parallelogram *represents* the sum or *resultant* of the two given forces. As shown in

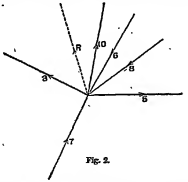


Fig. 2.

the figure, O C really represents the *equilibrant* of the two given forces, meaning that which balances or equilibrates them; but if its arrow-head be changed so as to point from O to C, O C will represent the *resultant* or sum required. Remember that before you can construct such a parallelogram as here shown, both your vectors must point *away from*, or both *towards* the point at which they meet. If you examine the figure a little, you will see that only one-half of the parallelogram is really required; for A C will represent one of the forces

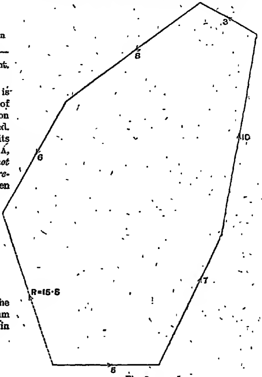


Fig. 3.

just as well as O B; the fact that A C is not drawn from O does not matter, since we know that the required resultant must act at O, and the triangle O A C could be drawn somewhere else on the paper and the resultant transferred to the proper point. Now notice that the arrow-heads on the triangle *point the same way round*, and you have the key to the construction required in all such cases. The condition of things may be stated thus:—*If two forces or other vector quantities act at a given point, then if a triangle be constructed two sides of which represent the two forces, the third or closing side will represent the equilibrant of the two forces if the arrow-heads of the figure point concurrently;* and the equilibrant is the resultant with its arrow-head reversed. The same thing holds good of a larger number of vector quantities, in that case the figure becomes a polygon, and is called the

"polygon of forces," or velocities, or accelerations as the case may be. It is not necessary even that the sides of the polygon shall lie all in one plane, as will be explained presently.

Before going further, the student should get a

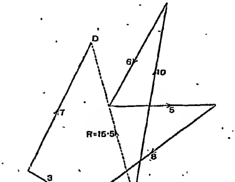


Fig. 4.

sheet of paper and drawing instruments, and actually find the resultant of the forces shown in Fig. 2. In Figs. 3 and 4 the example is shown worked out. In Fig. 3 the forces are taken in such order as to give a polygon of the usual kind, whilst in Fig. 4 the forces are taken without reference to order, and the polygon is of the shape shown. In each the dotted line marked R shows the resultant.

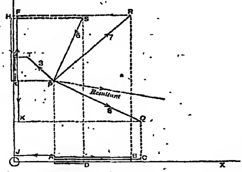


Fig 5.

The question could. of course, be worked equally well by taking the forces in the order in which they follow each other in Fig. 2; and in that case the polygon would have re-entrant angles, like that shown in Fig. 4. I have given these two figures in order to emphasise the fact that the order in which the forces are taken does not matter, so long as each side of your polygon represents a particular force, and the arrow-heads point the same way round.

There is yet another way of solving such a question as this, and I refer to it because the principle involved may be of great use to the student later on. Let forces (or other vector quantities) act at the point P, and be such that they are *represented* by the lines P Q, P R, P S, P T (Fig. 5), the forces being 8, 7, 6, and 3 units respectively. If each of the lines P Q, etc., is projected on two lines O X and O Y, which intersect at right angles, and if, further, the *algebraic sum* of the horizontal projections be taken, together with the algebraic sum of the vertical projections, to form the two adjoining sides of a rectangle, its diagonal will represent the resultant of the forces to the same scale to which each of the lines P Q, etc., represents its particular force.

If Figs. 5 and 6 be carefully examined, it will be seen that L M, Fig. 6, is equal to A B + A C − A D − A J, in Fig. 5, and that L N is equal to E H + E K − E F − E G; these being respectively the horizontal and vertical projections of the lines P Q, etc., and representing the horizontal and vertical *components* of the respective forces, N M representing their resultant. I will not go further into this matter, but the student who knows a little trigonometry can easily *calculate* the vectors here obtained by drawing. This has been called the analytical method of solving such questions.

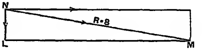


Fig. 6.

ILLUSTRATION OF OUR LAW.

The student will not readily appreciate the truth of such a law as the polygon of forces unless he make a quantitative experiment with a simple apparatus, such as he may readily construct.

Thus, in the apparatus shown in Fig. 7, three forces act on a small body and are allowed to assume a position of equilibrium. A triangle is then constructed with sides parallel respectively to the three forces; it will be found by measurement that the sides are also of lengths proportional to the forces, and as will be seen the arrow-heads point concurrently round the triangle. Here, then, is a practical illustration of the law, and when anyone performs this experiment, or a similar one with more than three forces, his knowledge of this

particular law is of a kind which he can apply with confidence. The student who has a little enterprise may try whether the law is fulfilled when the

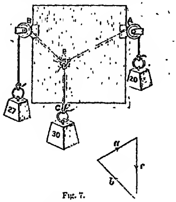


Fig. 7.

forces act in *different planes*. For this he will require such an apparatus as that represented in Fig. 8. In this case six known forces act by the strings O P, O Q, O R, O S, O T, O V on a small body at O, these strings, or forces, being in different planes.

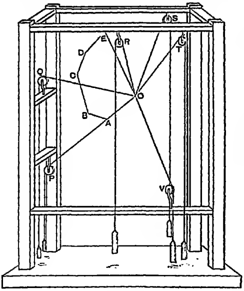


Fig. 8.

Now, when things have attained a position of equilibrium, if a piece of wire be attached to O, and bent along O P for a distance O A, of as many centimetres (say) as there are units in the force O P, then bent sharply at A in the direction A B, parallel to the force O Q, A B being of such a length as to represent the force O Q, and so on (the sides of the polygon of forces being in this case of wire, and *not* in the same plane), it will be found that the polygon is closed, and that the arrow-heads run round the figure concurrently just as before. It is evident, then, that the "polygon of forces" law is true whether the forces lie in one plane or not; when they do not lie in one plane the figure obtained is called a *gauche* polygon.

NUMERICAL EXAMPLES.

The easiest case of the summation of two vector quantities is that in which they are at right angles. The triangle in that case is right-angled, and there is no necessity for drawing it, as it is well known that if two sides of a right-angled triangle be given, the third is easily found from the fact that the square on the side opposite the right angle is equal to the sum of the squares on the other two sides.

1. A ship sails through the water at a uniform rate of 20 miles an hour, and a ball rolls across the deck at the same rate in a direction at right angles to the ship's course. Find the actual velocity of the ball.

Here the "triangle of velocities" is right-angled, the sides containing the right angle being each 20 units long. Let the other side be called R; it will represent the resultant or actual velocity of the ball, and it is found from the relation—

$$R^2 = 20^2 + 20^2,$$
$$\text{or } R = \sqrt{400 + 400} = \sqrt{800} = 28{\cdot}28 \text{ miles an hour.}$$

2. The wind blows from the north-east with a velocity of 20 miles an hour. Find the northerly and easterly components of its velocity.

In this case, also, the triangle is right-angled and isosceles, but the hypothenuse (or side opposite the right angle) being given, the other two sides are to be found. Calling each of them C, we have

$$20^2 = C^2 + C^2,$$
$$20^2 = 2C^2, \text{ or } \frac{20^2}{2} = C^2;$$
$$\therefore \sqrt{\frac{20^2}{2}} = C,$$
$$\text{or } \sqrt{\frac{400}{2}} = C,$$
$$\text{or } C = 14{\cdot}14.$$

Hence, the velocities required are each 14·14 miles an hour.

3. A body is pulled north, south, east, and west by four strings meeting at a point: if the forces in the strings are respectively 10, 15, 20, and 32 lb. weight, find their resultant.

In this case the four forces easily resolve into

two, for the northerly force of 10 lb. neutralises an equal amount of the southerly force, leaving a southerly force of 5 lb.; and in a similar way there is really a westerly force of 12 lb. The resultant is therefore

$$\sqrt{5^2 + 12^2} = \sqrt{169} = 13 \text{ lb.}$$

The student will notice that this is the first time I have mentioned the unit of force. I shall refer

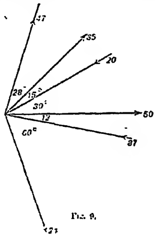


Fig. 9.

to this matter later on, but the unit of force in use among practical men in Britain is the force with which the earth attracts a pound weight in London.

4. Find, by construction, the equilibrant of the six forces represented in Fig. 9. The answer is shown in Fig. 10.

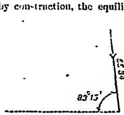


Fig. 10.

ALGEBRA.—XII.

[Continued from p. 283.]

DIVISION OF RADICAL QUANTITIES.

236. The division of radical quantities may be expressed by writing the divisor under the dividend, in the form of a fraction.

EXAMPLES.

Thus the quotient of $\sqrt[3]{a}$ divided by $\sqrt{b}$ is $\dfrac{\sqrt[3]{a}}{\sqrt{b}}$.

And $(a+h)^{\frac12}$ divided by $(b+x)^{\frac1n}$ is $\dfrac{(a+h)^{\frac12}}{(b+x)^{\frac1n}}$.

237. In these instances, the radical sign or index is *separately* applied to the numerator and denominator. But if the divisor and dividend are reduced to the *same* index or radical sign, this may be applied to the *whole* quotient.

Thus $\sqrt[n]{a} \div \sqrt[n]{b} = \dfrac{\sqrt[n]{a}}{\sqrt[n]{b}} = \sqrt[n]{\dfrac{a}{b}}$. For the root of a fraction is equal to the root of the numerator divided by the root of the denominator.

Again, $\sqrt[n]{ab} \div \sqrt[n]{b} = \sqrt[n]{a}$. For the product of this quotient into the divisor is equal to the dividend; that is, $\sqrt[n]{a} \times \sqrt[n]{b} = \sqrt[n]{ab}$. Hence—

Quantities under the same radical sign or index may be divided like rational quantities, the quotient being placed under the common radical sign or index.

EXAMPLE.—Divide $(x^3y^2)^{\frac12}$ by $y^{\frac13}$.

These reduced to the same index are $(x^3y^2)^{\frac36}$ and $(y^2)^{\frac16}$.

And the quotient is $(x^3)^{\frac12} = x^{\frac32} = x^{\frac32}$. *Ans.*

238. *A root is divided by another root of the same letter or quantity by subtracting the index of the divisor from that of the dividend.*

EXAMPLE.—Thus $a^{\frac12} \div a^{\frac13} = a^{\frac12 - \frac13} = a^{\frac36 - \frac26} = a^{\frac16} = a^{\frac16}$.

For $a^{\frac12} = a^{\frac36} = a^{\frac16} \times a^{\frac16} \times a^{\frac16}$, and this divided by $a^{\frac13}$ is $\dfrac{a^{\frac16} \times a^{\frac16} \times a^{\frac16}}{a^{\frac26}} = a^{\frac16} \times a^{\frac16} = a^{\frac26} = a^{\frac13}$.

In the same manner, $a^{\frac1m} \div a^{\frac1n} = a^{\frac1m - \frac1n} = a^{\frac{n-m}{mn}}$.

Powers and *roots* of the same letter may also be divided by each other, according to the preceding article.

Thus $a^2 \div a^{\frac13} = a^{2-\frac13} = a^{\frac53}$. For $a^{\frac53} \times a^{\frac13} = a^{\frac63} = a^2$.

239. *When radical quantities which are reduced to the same index have rational coefficients, the rational parts may be divided separately, and their quotient prefixed to the quotient of the radical parts.*

Thus $ac\sqrt{bd} \div a\sqrt{b} = c\sqrt{d}$. For this quotient multiplied into the divisor is equal to the dividend.

EXAMPLE.—Divide $ab\,(x^2b)^{\frac12}$ by $a\,(x)^{\frac14}$.

These reduced to the same index are $ab(x^2b)^{\frac12}$ and $a(x^2)^{\frac14}$.

The quotient then is $b(b)^{\frac12} = (b^3)^{\frac12}$.

To save the trouble of reducing to a common

index, the division may be expressed in the form of a fraction.

The quotient will then be $\frac{ab(x^2b)^{\frac{1}{n}}}{a(x)^{\frac{1}{n}}}$.

240. Hence we deduce the following

GENERAL RULE FOR DIVIDING RADICALS.

If the radicals consist of the same letter or quantity, subtract the index of the divisor from that of the dividend, and place the remainder over the common radical part or root.

If the radicals have coefficients, the coefficient of the dividend must be divided by that of the divisor.

If the quantities have the same radical sign or index, divide them as radical quantities, and place the quotient under the common radical sign.

Exercise 55.

1. Divide $\sqrt{6a^4x}$ by $\sqrt{3x}$.
2. Divide $\sqrt{dh^2x^2}$ by $\sqrt{dx}$.
3. Divide $(a^3+ax)^{\frac{1}{5}}$ by $a^{\frac{1}{5}}$.
4. Divide $(a^3h)^{\frac{1}{m}}$ by $(ax)^{\frac{1}{m}}$.
5. Divide $(a^3y^2)^{\frac{1}{4}}$ by $(ay)^{\frac{1}{4}}$.
6. Divide $(3a)^{1\frac{1}{3}}$ by $(3a)^{\frac{5}{6}}$.
7. Divide $(ax)^{\frac{2}{3}}$ by $(ax)^{\frac{1}{3}}$.
8. Divide $a^{\frac{m+n}{nm}}$ by $a^{\frac{1}{m}}$.
9. Divide $(b+y)^{\frac{2}{n}}$ by $(b+y)^{\frac{1}{n}}$.
10. Divide $(x^2y^3)^{\frac{1}{7}}$ by $(x^2y^3)^{\frac{2}{7}}$.
11. Divide $24x\sqrt{ay}$ by $6\sqrt{a}$.
12. Divide $18dh\sqrt{bx}$ by $2h\sqrt{x}$.
13. Divide by $(a^3x^6)^{\frac{1}{n}}$ by $y(ax)^{\frac{1}{n}}$.
14. Divide $16\sqrt{32}$ by $8\sqrt{4}$.
15. Divide $b\sqrt{xy}$ by $\sqrt{y}$.

Exercise 56.

1. Divide $2\sqrt[3]{bc}$ by $3\sqrt{ac}$.
2. Divide $\sqrt[3]{8}$ by $\sqrt[3]{2}$.
3. Divide $10\sqrt[3]{108}$ by $5\sqrt[3]{4}$.
4. Divide $\sqrt[6]{32}$ by $\sqrt[3]{2}$.
5. Divide $\sqrt[8]{20}$ by $\sqrt[4]{5}$.
6. Divide $a\sqrt[12]{a}$ by $a^{\frac{2}{3}}$.
7. Divide $\sqrt[6]{a^3b^4}$ by $b^{\frac{2}{3}}$.
8. Divide $6\sqrt[6]{432}$ by $3\sqrt[3]{4}$.
9. Divide $-x^4$ by $\sqrt{-x^4}$.
10. Divide $\sqrt{7}$ by $\sqrt[4]{7}$.
11. Divide $5b\sqrt{b^3x}$ by $10x^3\sqrt{b^2x^5}$.
12. Divide $2\sqrt{5}$ by $3\sqrt[3]{4}$.

INVOLUTION OF RADICAL QUANTITIES.

241. To involve a radical quantity to any required power,

Multiply the index of the root into the index of the power to which it is to be raised.

EXAMPLE.—Thus the square of $a^{\frac{1}{3}} = a^{\frac{1}{3}\times 2} = a^{\frac{2}{3}}$. For $a^{\frac{1}{3}} \times a^{\frac{1}{3}} = a^{\frac{2}{3}}$.

242. *A root is raised to a power of the same name by removing the index or radical sign.*

N.B. When the radical quantities have *rational coefficients*, these must be involved by actual multiplication.

Thus the cube of $\sqrt[3]{b+x}$, is $b+x$

And the nth power of $(a-y)^{\frac{1}{n}}$, is $a-y$.

The square of $a\sqrt[n]{x}$, is $a^2\sqrt[n]{x^2}$.

For $a\sqrt[n]{x}\times a\sqrt[n]{x}=a^2\sqrt[n]{x^2}$.

But if the radical quantities are connected with others by the signs $+$ and $-$, they must be involved by a multiplication of the several terms.

EXAMPLE.—Required the square of $a+\sqrt{y}$ and of $a-\sqrt{y}$.

$$\begin{array}{rr} a+\sqrt{y} & a-\sqrt{y} \\ a+\sqrt{y} & a-\sqrt{y} \\ \hline a^2+a\sqrt{y} & a^2-a\sqrt{y} \\ a\sqrt{y}+y & -a\sqrt{y}+y \\ \hline a^2+2a\sqrt{y}+y. & a^2-2a\sqrt{y}+y. \end{array}$$

Exercise 57.

1. Required the cube of $a^{\frac{1}{3}}$.
2. Required the nth power of $a^{\frac{1}{n}}$.
3. Required the 5th power of $a^{\frac{1}{5}}y^{\frac{1}{5}}$.
4. Required the cube of $a^{\frac{1}{n}}x^{\frac{1}{m}}$.
5. Required the square of $a^{\frac{1}{2}}x^{\frac{1}{2}}$.
6. Required the cube of $a^{\frac{1}{3}}$.
7. Required the nth power of $a^{\frac{2}{n}}$.
8. Required the nth power of $a^m x^{\frac{1}{m}}$.
9. Required the square of $a\sqrt{x-y}$.
10. Required the cube of $3a\sqrt[3]{y}$.
11. Required the cube of $a-b\sqrt{-1}$.
12. Required the cube of $a-\sqrt{b}$.
13. Required the 4th power of $\sqrt{d}$.
14. Required the 4th power of $-\sqrt{x-1}$.
15. Required the 6th power of $\sqrt{a+b}$.

EVOLUTION OF RADICAL QUANTITIES.

243. The operation for finding the *root* of a quantity which is *already a root*, is the same as in other cases of evolution. Hence we derive the following

RULE FOR THE EVOLUTION OF RADICALS.

Divide the fractional index of the quantity by the number expressing the root to be found. Or,

Place the radical sign belonging to the required root over the given quantity.

If the quantities have rational coefficients, the root of these must be extracted and placed before the radical sign or quantity.

EXAMPLE.—Thus the square root of $a^{\frac{1}{3}}$, is $a^{\frac{1}{3}\div 2} = a^{\frac{1}{6}}$.

From the preceding rules it will be perceived that *powers* and *roots* may be brought promiscuously together, and subjected to the same modes of operation.

Exercise 58.

1. Find the cube root of $a(xy)^{\frac{1}{2}}$.
2. Find the nth root of $a\sqrt[5]{by}$.
3. Find the 4th root of $\sqrt{a}\times\sqrt[5]{b}$.
4. Find the 7th root of $128\sqrt[7]{d}$.
5. Find the 4th root of $81a^4$.
6. Find the 6th root of $(a+b)^3$.
7. Find the nth root of $(x-y)^{\frac{1}{n}}$.

8. Find the cube root of $-125a^3x^6$.
9. Find the square root of $\frac{4a^4}{9x^2y^2}$.
10. Find the square root of $x^2 - 6bx + 9b^2$.
11. Find the 5th root of $-\frac{32a^5x^{10}}{243}$.
12. Find the square root of $a^2 + ay + \frac{y^2}{4}$.
13. Reduce ax^2 to the form of the 6th root.
14. Reduce $-3y$ to the form of the cube root.
15. Reduce a^2 and $a^{\frac{1}{2}}$ to a common index.
16. Reduce $4^{\frac{1}{2}}$ and $5^{\frac{1}{4}}$ to a common index.
17. Reduce $a^{\frac{1}{2}}$ and $b^{\frac{1}{4}}$ to the common index $\frac{1}{4}$.
18. Reduce $2^{\frac{1}{2}}$ and $4^{\frac{1}{4}}$ to the common index $\frac{1}{8}$.
19. Remove a factor from $\sqrt{294}$.
20. Remove a factor from $\sqrt{x^3 - a^2x^2}$.
21. Find the sum and difference of $\sqrt{16a^2x}$ and $\sqrt{4a^2x}$.
22. Find the sum and difference of $\sqrt[3]{192}$ and $\sqrt[3]{24}$.
23. Multiply $7\sqrt[3]{18}$ into $5\sqrt[3]{4}$.
24. Multiply $4 + 2\sqrt{2}$ into $2 - \sqrt{2}$.
25. Multiply $3 + \sqrt{-2}$ by $2 - 3\sqrt{-1}$.
26. Multiply $a - b\sqrt{-c}$ by $a + b\sqrt{-c}$.
27. Divide $\sqrt{2}$ by $\sqrt[3]{2}$.
28. Divide $\sqrt[4]{6}$ by $\sqrt[3]{2}$.
29. Divide $5\sqrt{12}$ by $\sqrt[4]{2}$.
30. Divide $4\sqrt[4]{3}$ by $\sqrt{2}$.
31. Find the cube of $3\sqrt{2}$.
32. Find the square of $2\sqrt{3}$.
33. Find the 4th power of $1 + \sqrt{2}$.
34. Find the cube of $2 + \sqrt{5}$.

REDUCTION OF EQUATIONS BY INVOLUTION.

214. In an equation the letter which expresses the unknown quantity is sometimes found under a *radical sign.* We may have $\sqrt{x} = a$.

To clear this of the radical sign, let each member of the equation be squared; that is, multiplied into itself. We shall then have $\sqrt{x} \times \sqrt{x} = aa$. Or, $x = a^2$.

The equality of the sides is not affected by this operation, because each is only multiplied into itself; that is, equal quantities are multiplied into equal quantities.

The same principle is applicable to any root whatever. If $\sqrt[n]{x} = a$, then $x = a^n$. For a root is raised to a power of the same name by removing the index or radical sign.

Hence, to reduce an equation when the unknown quantity is under a radical sign,

Involve both sides to a power of the same name as the root expressed by the radical sign.

N.B. It will generally be expedient to make the necessary transpositions, and to clear the equation of fractions, *before* involving the quantities; so that all those which are not under the radical sign may stand on one side of the equation.

EXAMPLES.

Reduce the equation, $\sqrt{x} + 4 = 9$.
Transposing $+ 4$, $\sqrt{x} = 9 - 4 = 5$.
Involving both sides, $x = 5^2 = 25$. *Ans.*

Reduce the equation, $a + \sqrt[n]{x} - b = d$.
By transposition, $\sqrt[n]{x} = d + b - a$.
By involution, $x = (d + b - a)^n$. *Ans.*

EXERCISE 59.

1. Reduce the equation $\sqrt[4]{x + 1} = 4$.
2. Reduce the equation $4 + 3\sqrt{x - 4} = 6 + \frac{1}{2}$.
3. Reduce the equation $\sqrt[3]{(4x + 7)} + 4 = 18$.
4. Reduce $\sqrt{2x - 10} + 4 = 14$.
5. Reduce $\sqrt[4]{\frac{x}{5}} = 8$.
6. Reduce $(2x + 3)^{\frac{1}{3}} + 4 = 8$.
7. Reduce $\sqrt{12 + x} = 2 + \sqrt{x}$.
8. Reduce $\sqrt{(3x + 1)} + 5 = 10$
9. Reduce $\sqrt{(x + a)} = c - \sqrt{(x + b)}$.
10. Reduce $\sqrt[3]{(ax - bx)} = c$.
11. Reduce $\frac{\sqrt{x} + 28}{\sqrt{x} + 4} = \frac{\sqrt{x} + 38}{\sqrt{x} + 6}$.
12. Reduce $\sqrt{x} + \sqrt{a + x} = \frac{2a}{\sqrt{(a + x)}}$.
13. Reduce $x + \sqrt{a^2 + x^2} = \frac{2a^2}{\sqrt{(a^2 + x^2)}}$.
14. Reduce $x + a = \sqrt{a^2 + x\sqrt{(b^2 + x^2)}}$.
15. Reduce $\sqrt{2 + x} + \sqrt{x} = \frac{4}{\sqrt{(2 + x)}}$
16. Reduce $\sqrt{x - 32} = 16 - \sqrt{x}$.
17. Reduce $\sqrt{4x - 17} = 2\sqrt{x} + 1$.
18. Reduce $\frac{\sqrt{(6x)} - 2}{\sqrt{(6x)} + 2} = \frac{4\sqrt{(6x)} - 9}{4\sqrt{(6x)} + 6}$.

REDUCTION OF EQUATIONS BY EVOLUTION.

215. In many equations the letter which expresses the unknown quantity is involved to some power. Thus,

in the equation $x^2 = 16$.

we have the value of the *square* of x, but not of x itself.

If the square root of both sides be extracted,

we shall have $x = 4$.

The equality of the members is not affected by this reduction. For if two quantities or sets of quantities are equal, their roots are also equal.

If $(x + a)^n = b + h$, then $x + a = \sqrt[n]{b + h}$. Hence,

To reduce an equation when the unknown quantity is a power,

Extract the root of both sides which corresponds with the power expressed by the index of the unknown quantity.

EXAMPLES.

1. Reduce the equation $6 + x^2 - 8 = 7$.
By transposition, $x^2 = 7 + 8 - 6 = 9$.
By evolution, $x = \pm\sqrt{9} = \pm 3$. *Ans.*

The signs $+$ and $-$ are both placed before $\sqrt{9}$, because an even root of an affirmative quantity is *ambiguous.*

2. Reduce the equation $5x^2 - 30 = x^2 + 34$.
Transposing, etc., $x^2 = 16$.
By evolution, $x = \pm 4$. *Ans.*

From the preceding articles it will be easy to see that to reduce an equation containing a root of a power, requires both *involution* and *evolution.*

EXAMPLE.

Reduce the equation $\sqrt[3]{x^2} = 4$.
By involution, $x^2 = 4^3 = 64$.
By evolution, $x = \pm\sqrt{64} = \pm 8$. *Ans.*

EXERCISE 60.

1. Reduce the equation $ax^2 - 5c = bx^2 - 3c + d$.
2. Reduce the equation $a + dx^n = 10 - x^n$.
3. Reduce the equation $\sqrt{x^n - v} = h - d$.
4. Reduce the equation $(x + a)^{\frac{1}{2}} = \sqrt{x + \sqrt{b^2 + x^2}}$.
5. Reduce the equation $(x^2 - 1)^{\frac{1}{2}} = \dfrac{8}{(x^2-1)^{\frac{1}{2}}}$.
6. Reduce the equation $\sqrt{x^2 - 11} = 5$.
7. Reduce the equation $\sqrt{y^2 - 4ab} = a - b$.
8. Reduce the equation $(13 + \sqrt{23 + x^2})^{\frac{1}{2}} = 5$.
9. Reduce the equation $(3 + \sqrt[3]{329 + x^3})^2 = 141$.

PROBLEMS.

1. A gentleman being asked his age, replied, "If you add to it 10 years, and extract the square root of the sum, and from this root subtract 2, the remainder will be 6." What was his age?

Let x = his age.

By the conditions of the problem,

$$\sqrt{x + 10} - 2 = 6.$$

By transposition, $\sqrt{x + 10} = 6 + 2 = 8$.
By involution, $x + 10 = 8^2 = 64$.
And $x = 64 - 10 = 54$ years.

Proof. $\sqrt{54 + 10} - 2 = 6$.

2. If to a certain number 22577 be added, and the square root of the sum be extracted, and from this 163 be subtracted, the remainder will be 237. What is the number?

Let x = the number sought, $b = 163$,
$a = 22577$, $c = 237$.

By the conditions proposed, $\sqrt{x + a} - b = c$.
By transposition, $\sqrt{x + a} = c + b$.
By involution, $x + a = (c + b)^2$.
And $x = (c + b)^2 - a$.
Restoring the numbers, $x = (237 + 163)^2 - 22577$.
That is $x = 160000 - 22577$.
$= 137423$ = required number.

Proof. $\sqrt{137423 + 22577} - 163 = 237$.

When an equation is reduced by extracting an even root of a quantity, the solution does not always determine whether the answer is positive or negative. But what is thus left ambiguous by the algebraic process is frequently settled by the statement of the problem.

EXERCISE 61.—MISCELLANEOUS PROBLEMS.

1. A merchant gains in trade a sum to which 320 pounds bears the same proportion as five times this sum does to 2500. What is the amount gained?

2. The distance to a certain place is such, that if 96 be subtracted from the square of the number of miles, the remainder will be 48. What is the distance?

3. If three times the square of a certain number be divided by 4, and if the quotient be diminished by 12, the remainder will be 180. What is the number?

4. What number is that, the fourth part of whose square being subtracted from 8, leaves a remainder equal to 4?

5. What two numbers are those, whose sum is to the greater as 10 to 7; and whose sum multiplied into the less produces 270?

6. What two numbers are those, whose difference is to the greater as 2 to 9, and the difference of whose squares is 128?

7. It is required to divide the number 18 into two such parts, that the squares of those parts may be to each other as 25 to 16.

8. It is required to divide the number 14 into two such parts that the quotient of the greater divided by the less may be to the quotient of the less divided by the greater as 16 to 9.

9. What two numbers are as 5 to 4, the sum of whose cubes is 5103?

10. Two travellers, A and B, set out to meet each other, A leaving the town C at the same time that B left D. They travelled the direct road between C and D; and on meeting, it appeared that A had travelled 18 miles more than B, and that A could have gone B's distance in 15¾ days, but B would have been 28 days in going A's distance. Required the distance between C and D.

11. Find two numbers which are to each other as 8 to 5, and whose product is 360.

12. A gentleman bought two pieces of silk, which together measured 36 yards. Each of them cost as many shillings per yard as there were yards in the piece, and their whole prices were as 4 to 1. What were the lengths of the pieces?

13. Find two numbers which are to each other as 3 to 2; and the difference of whose fourth powers is to the sum of their cubes as 26 to 7.

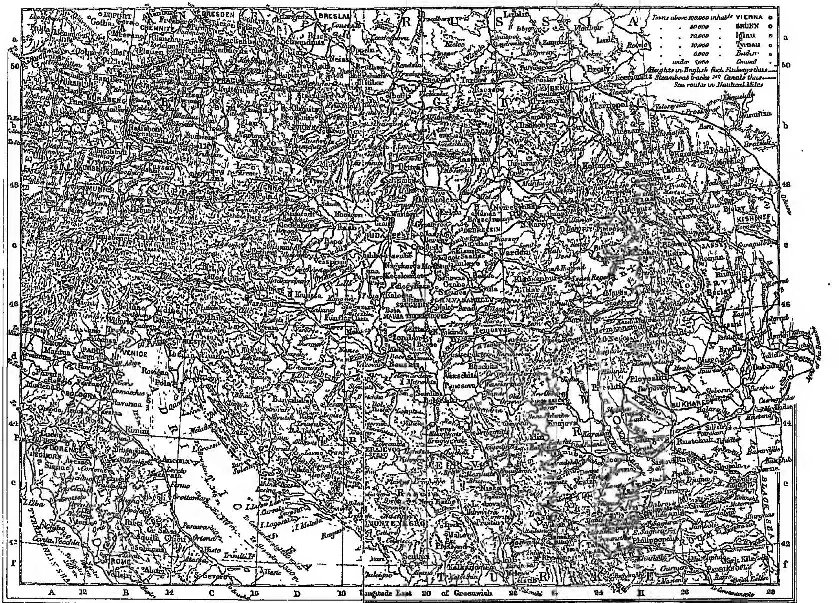
14. Several gentlemen made an excursion, each taking the same sum of money. Each had as many servants attending him as there were gentlemen; the number of crowns which each had was double the number of all the servants, and the whole sum of money taken out was 3456 crowns. How many gentlemen were there?

15. A detachment of soldiers from a regiment being ordered to march on a particular service, each company furnished four times as many men as there were companies in the whole regiment; but these being found insufficient, each company furnished three men more; when their number was found to be increased in the ratio of 17 to 16. How many companies were there in the regiment?

KEY TO EXERCISES.

EXERCISE 47.

1. $\sqrt[5]{ab}$.
2. $a^{\frac{2}{5}}$.
3. $(2d - x)^{\frac{1}{7}}$.
4. $(a - x)^{\frac{3}{7}}$.
5. $a^{\frac{1}{4}}$.
6. $a^{-\frac{1}{4}}$.
7. $a^{\frac{7}{9}}$.
8. $x^{\frac{11}{m}}$.



English Miles.
0 10 20 30 40 50 100 200
Natural Scale 1:7 000 000

London: Cassell & Company, Limited.

Geographical or Nautical Miles.
0 10 20 30 40 50 100 200

F. S Weller, F.R.G.S

9. y^3.
10. x^2.
11. $x^{\frac{m}{3}}$.
12. $d^{\frac{1}{2}}$.
13. $a^{\frac{1}{n}}$.
14. $3^{\frac{1}{3}}y^{\frac{1}{3}}$ or $(3y)^{\frac{1}{3}}$.
15. $a^{\frac{1}{4}}b^{\frac{1}{4}}c^{\frac{1}{4}}$ or $\sqrt[4]{abc}$.
16. $2\sqrt[3]{b}$ or $2b^{\frac{1}{3}}$.
17. $x\sqrt[n]{y}$ or $xy^{\frac{1}{n}}$.
18. $\frac{\sqrt[n]{a}}{\sqrt[n]{b}}$ or $\left(\frac{a}{b}\right)^{\frac{1}{n}}$ and $\left(\frac{c}{d^2}\right)^{\frac{1}{2}}$.
19. $\left(\frac{x}{ay}\right)^{\frac{1}{3}}$ and $\left(\frac{b^3}{c^4}\right)^{\frac{1}{4}}$.
20. $x - 1$.
21. $a + \frac{1}{2}$.
22. $a + \frac{1}{3}$.
23. $a + \frac{b}{2}$.
24. $a + \frac{b}{c}$

Exercise 48.

1. $\sqrt[3]{64}$.
2. $\sqrt[4]{81a^4}$.
3. $\sqrt{9a^2b^2}$.
4. $27(a-x)^3)^{\frac{1}{3}}$ or $\sqrt[3]{27(a-x)^3}$.
5. $\sqrt[3]{a^6}$ or $a^{\frac{6}{3}}$.
6. $\sqrt{a^6b^3}$.
7. $a^{\frac{mn}{n}}$.
8. $(a^{2n})^{\frac{1}{n}}$ and $b^{\frac{1}{n}}$.
9. $(x^m)^{\frac{1}{mn}}$ and $(y^n)^{\frac{1}{mn}}$.
10. $(2^3)^{\frac{1}{6}}$ and $(3^2)^{\frac{1}{6}}$
11. $\sqrt[3]{(a+b)^6}$ and $\sqrt[3]{(z-y)^3}$.
12. $(a^5)^{\frac{1}{15}}$ and $(b^3)^{\frac{1}{15}}$.
13. $(x^4)^{\frac{1}{6}}$ and $(5^3)^{\frac{1}{6}}$.
14. $(4^3)^{\frac{1}{6}}$ and $(3^2)^{\frac{1}{6}}$.
15. $(x^{12})^{\frac{1}{6}}$ and $(y^{20})^{\frac{1}{6}}$.
16. $(a^3)^{\frac{1}{6}}$ and $(b^2)^{\frac{1}{6}}$.
17. $(c^{\frac{4}{3}})^{\frac{2}{6}}$ and $(d^{\frac{3}{5}})^{\frac{2}{6}}$.
18. $\left(a^{\frac{n}{m}}\right)^{\frac{1}{n}}$ and $\left(b^{\frac{2n}{m}}\right)^{\frac{1}{n}}$.
19. $(a^6)^{\frac{1}{12}}$, $(b^4)^{\frac{1}{12}}$, and $(c^3)^{\frac{1}{12}}$.

Exercise 49.

1. $3\sqrt{2}$.
2. $4b^2\sqrt{c}$.
3. $\frac{c}{c}\sqrt[4]{\frac{b}{cd}}$.
4. $a^n\sqrt{b}$.
5. $a(a-b)^{\frac{1}{2}}$.
6. $8a^2(2h)^{\frac{1}{3}}$.
7. $7a\sqrt{2r}$
8. $a\sqrt[3]{(1+b^2)}$.
9. $(16a^4b^2)^{\frac{1}{3}}$.
10. $\left(\frac{a^4b^2c}{a^2b^2+b^4}\right)^{\frac{1}{2}}$.
11. $\sqrt{5}$.
12. $\sqrt{16b^6c}$.
13. $\sqrt{150}$.
14. $\sqrt{\frac{a}{5}}$
15. $(5^3)^{\frac{1}{6}}$ and $(6^2)^{\frac{1}{6}}$.
16. $(a^3)^{\frac{1}{6}}$ and $(a^2)^{\frac{1}{6}}$.
17. $7\sqrt{2}$.
18. $9\sqrt{3}$.
19. $\sqrt[3]{2}$.
20. $28\sqrt{5}$.
21. $27\sqrt[3]{3}$.
22. $x\sqrt{(1+a)}$.
23. $3a\sqrt{22x}$.
24. $x\sqrt{x-a^2}$.

Exercise 50.

1. $8\sqrt[n]{ay}$
2. $3\sqrt{a}$
3. $7(x+h)^{\frac{1}{2}}$.
4. $12bh^{\frac{1}{6}}$.
5. $(a+y)\sqrt{b-h}$.
6. $6\sqrt{b}$.
7. $(a+b^2)\sqrt{x}$.
8. $(6r+5)\sqrt{y}$.
9. $6\sqrt{2r}$.

Exercise 51.

1. $7\sqrt{3}$.
2. $14\sqrt{2}$.
3. $15\sqrt{5}$.
4. $9\sqrt[3]{5}$.
5. $32\sqrt[3]{2}$.
6. $191\sqrt{3}$.
7. $16\sqrt{b}$.
8. $7a\sqrt{d}$.
9. $11x^2\sqrt{c}$.
10. $7a^2\sqrt[3]{b}$.

Exercise 52.

1. $-2\sqrt{ay}$.
2. $\sqrt[n]{(a+x)}$
3. $8h^{\frac{1}{2}}$.
4. $(a-b)(x+y)^{\frac{1}{2}}$.
5. c^n.
6. $3\sqrt{2}$
7. $(b-y)^3\sqrt{by}$.
8. $\sqrt[n]{x}-\sqrt[5]{x}$.
9. $\frac{7}{4}\sqrt{2}$.
10. $2\sqrt[3]{5}$.
11. $\sqrt{5}$.
12. $4a^2 - 2a\sqrt{5x}$.

Exercise 53.

1. $\sqrt{a^2-m^2}$.
2. $\sqrt{dhxy}$.
3. $\sqrt{a^2x}$.
4. $\sqrt[n]{(a+y)(b+h)}$.
5. $\sqrt[mn]{a^nz^m}$.
6. $4xb$.
7. ay.
8. $2y^{\frac{11}{12}}$.
9. $(a+b)^{\frac{1}{n}}$.
10. $(a-y)^{\frac{m+n}{mn}}$.
11. $x^{\frac{7}{12}}$.
12. $y^{\frac{1}{6}}$.
13. $x^{\frac{nq-np}{nq}}$
14. $x^{-\frac{17}{6}}$ or $\frac{1}{x^2\sqrt[6]{x^5}}$.
15. $a^{\frac{1}{5}}$.
16. $a+b$.
17. $a^{\frac{23}{10}}$ or $a^2\sqrt[10]{a^3}$.
18. $ab(x^3d^n)^{\frac{1}{n}}$.
19. $ay(b^2-x^2)^{\frac{1}{2}}$.
20. $aby\sqrt{hy}$.
21. abx.
22. $abx^{-\frac{1}{2}}y^{-\frac{1}{3}}$.
23. $3xy$.
24. $\frac{1}{b}\sqrt[3]{b^2}$

Exercise 54.

1. $130\sqrt[15]{a^{13}}$
2. $2\sqrt[n]{x^4yz^{-7}}$.
3. $am\sqrt[6]{x^3y^2}$
4. $\frac{1}{5}\sqrt[3]{15}$
5. $20\sqrt[6]{x^5}$
6. $12\sqrt[3]{7}$.
7. $-y$.
8. $1-\frac{2}{3}\sqrt{2}$.
9. $a^2 - 2az + z^2 + m^2$.
10. $-184(a+c)^{\frac{m+n}{mn}}$.
11. $\sqrt[120]{a^{61}}$, or $\sqrt[120]{a}\sqrt{a}$.
12. $a^{\frac{1}{12}}b^{-\frac{5}{12}}c = \frac{c}{b}\sqrt[12]{\frac{a}{b^5}}$.

WATER-COLOUR DRAWING.—IV.

[*Continued from p. 278.*]

EFFECT OF COMBINATION OF COLOURS—CONCLUSION.

As we are desirous that these lessons upon painting in water-colours should, as far as possible, explain the principles of the art, we deem it necessary to include other subjects for our consideration besides that of landscape. By these further investigations we shall add to our means of explaining the theory, and open out a more extensive field for practice. All who have had any considerable experience in painting can testify to the benefit that is derived from allowing their attention and practice to extend to other objects, rather than by confining them to one class only; and although the objects of our choice may differ in kind and character as widely as possible, yet the same colours and manner of execution may to a great extent be common to all. Besides, the knowledge and power we gain, directly or indirectly, from the study of one class may be found serviceable when we take up others—directly, when the same colours and method of using them may be repeated; indirectly, in teaching us that there are certain combinations and modes of treatment which can only be employed in special cases, all of which must give us a command, both of manner and material, that cannot fail to be of advantage to us upon all occasions.

When we consider that the proper application of colours lies in their arrangement and combinations, we shall not be at a loss to understand in what respect the diversity of study we speak of can help us to overcome the difficulties. Hence the source

of originality, from depending principally upon our own observations. It is true we may in a great measure be guided by the experience of others, and it would be unwise to reject it; but as each painter has his own innate feeling, both of form and colour, which influences him in his method of representing either, we may easily account for the way in which every one makes for himself his own style and manner, peculiar to himself alone. On the other hand, they who entirely depend upon other men's experience, without looking away from it to Nature for the reasons which guided them in their practice, are but copyists, and more frequently copy the faults rather than the excellences of their masters. Let us suppose the case of two painters who have been in the habit of taking Nature as their guide, and ask each to paint the same subject according to his own ideas and the results of his own experience: we shall find their practice and theory so different as to make us almost doubt the possibility of their coming closely together at the conclusion; yet we find their finished pictures, when compared with the subject from which they were painted, to be truthful representations, but each in a different way.

Fig. 10.

It is then our desire to encourage our pupils to think for themselves, and to endeavour, as far as possible, to show them *how to* look at Nature, and *how* to distinguish the characteristic features which mark the individuality of objects, even amongst those of the same species. Whatever the experience of an artist may be, he cannot say positively that such and such colours are to be used invariably, even for the same class of objects, because there are so many accidental circumstances operating to influence him in his mode of proceeding. The light may be different at different times, it may be stronger or brighter on one occasion than another. This would very much affect reflections, and especially so if the surrounding objects sent back their colours under a powerful light; and besides, the very objects themselves, though precisely the same in class and character, may, from various causes, exhibit different degrees of colour—brighter, warmer, or colder, as the case might be. But the artist may be able to explain how colours are affected in their combinations, and how they may be used to neutralise or give more force to other colours under any particular arrangement, or when employed for some especial purpose; therefore, in order to give a practical illustration of our observations, we have selected a group of objects differing in colour, but belonging to the same classification, to form the subject of our next picture (Fig. 10). Our pupils may easily obtain any of these, and place them on the table as they are arranged in the engraving, with the light from the left. Now, as there are great varieties of these, especially the stable-lantern and the jar, in size and details of colour, it is obvious that there can be no positive directions given as to the exact colour to be used, either in quantity or order; therefore we can only

explain the principles upon which they must proceed in painting them, that our pupils may be able to make their own deductions.

We will commence with the jar. The majority of articles of this kind are of a dark-brown, warm colour, from the top to about one-third of the distance downwards; there are some of a pale sickly yellow, approaching in tone to the rest of the colour below, but we prefer to take the darker. The prevailing colour in the upper portion is burnt sienna. The jar may not be very evenly stained, but should there be darker portions than the middle tones of sienna just mentioned (*a*, *a*, Fig. 10), paint them in, whilst the first wash of sienna is wet, with some madder brown, and a little sepia mixed with it for the darkest portions. The yellowish drab tone below may be imitated with yellow ochre, raw umber, and very little grey, the latter composed of sepia, cobalt blue, and a little lake. In the lower part of some jars there is a very slight tone approaching lake. This may be added to the colour at the time, or perhaps it would be better to leave it till the umber, ochre, and grey tone is dry, then glaze it with the lake; but as this colour will be so very faint as to be almost imperceptible, a very weak tint must be used. Here is an instance of delicate tones so frequently found in Nature, and which give so much value to the painting, and are so very difficult for beginners to detect; it requires much experience to recognise them, and in first attempts the great

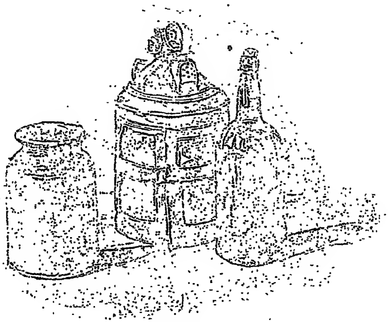


Fig. 11.

danger is in overdoing them. We caution our pupils, when glazing colours over others that are dry, not to rub the brush backwards and forwards, because the first time the brush goes over the undertone the colour is softened, a repetition of this will rub it up, and then the purity is lost; the brush must be carefully passed over every part, and once only. We recommend the practice of trying the most prominent and positive colours, when prepared, on a piece of paper, and then hold it near to those parts of the object corresponding to the colour; this practice will greatly assist the judgment in determining the exact tone required.

With respect to more decisive colours, to be found scattered in places over an object—but not altogether, as in the case of any general delicate tone like the one mentioned above—we advise that particular notice should be taken where they are warmer or cooler. These changes of colour are

universal in Nature, and demand all the care that we can patiently bestow upon them. It is necessary to observe the strength of the colour either way which causes the difference, and when the underground is dry, wash the required tint over it. In the case of the jar before us there is a warm tint over *b*, *b* of raw umber and burnt sienna, the edges being broken off over the under colour until they are lost on the side of the light, and on the shadow side mingle with a cool grey near the edge of the jar. The next thing will be to put in the broad and cast shadows with the usual shadow tint—sepia, cobalt, and lake. The darkest portion on the object will be throughout the length, between *b*, *b* and *c*, *c*, making it sharp and decisive at *c*, *c*. The edge must be washed off on the light side, and continued on the shadow side with a somewhat lighter and cooler tone to the side of the jar. The cast shadow must be darker than the broad shadow. The shining bright spots, *d*, *d*, being the highest lights, may be wetted and rubbed off with india-rubber, as we explained in a former lesson upon sepia painting. The inside of the jar may require a purer yellow than the outside; if so, less umber must be used, and the brown colouring over the rim may be sharp and distinct in its edges. If our pupils will look at their model more attentively, after this first process is completed, they will no doubt perceive other colours more or less influencing the general effect—slight glazings of lake over some parts of the brown, especially on the light side. Probably here and there, in connection with these, some similar glazings of raw sienna, where the brown is not so strong and partakes of that colour; even delicate washes of indigo may be seen; but it must be remembered these are only suggestions, and must be followed with judgment.

The next part of the subject to be considered is the lantern. The general colour here is grey. The horn through which the light passes will most probably be warmer in tone. This may be effected with burnt and raw sienna broken to different degrees of strength, and for the clearer parts a little yellow ochre may be useful. If the lantern is an old one, patches of rust may be scattered over it in places—Indian red will answer the purpose; but, as we have said, grey is the prevailing colour, diversified by warmer or cooler colours, subject to the manner in which they are disposed in the object. The darkest and very sharp shadows under the rim and in the corners can be imitated with sepia, indigo, and a little lake. There is a greenness about sepia and indigo alone which lake will neutralise and render the tint more intense.

It will be well now to paint the background; this will reveal the strength of the colours in the objects, and very likely we shall discover some parts deficient. Let this at first be done with grey tint (backgrounds must be of a retiring character; grey will accomplish this), till it descends to below the top of the jar, then continue it to the bottom with an addition of raw umber and yellow ochre. If after this is dry a wash of terre-verte be passed over the grey only, the slight green thus contributed will increase by contrast the value of the red, and confine the greys of the lantern more particularly to itself.

Lastly, the bottle. This is a dark object, and affords a powerful contrast to the others, assisting to give the greys and lighter tones in the lantern their true value and strength. The principal and general colour will be sepia and indigo; but this will be broken up by a variety of other colours depending upon the objects which surround it. The narrow strips of middle tone at *a*, *a* were caused by the reflection of the jar and another object near it, not in the picture. The one *b* was from a saucer placed near to the bottle, and *c* was from a plaster cast that stood about two feet away from it. This being an object susceptible of reflection, everything near it has an influence upon the colour, and it must be remembered that the colours for these reflections are always those of the objects reflected. The cork may be painted with raw umber and a little ochre; the shadow sepia. The darkest parts of the bottle, not affected by reflection, must be put in with sharp decisive touches of very dark indigo and sepia. There will also be many cool tones to be painted with indigo. Very frequently it is necessary to assist the very darkest parts with a little gum. We do not advocate an indiscriminate use of gum; but in cases like this, to assist the intensity of the darkest parts, an exception may be made; only it must be used sparingly, or the intention would be frustrated.

Now we desire our pupils to understand that the above hints are given for the purpose of directing them *how to look at an object and to study its colour*. No absolute rule could be given for painting either this or any other subject; even if it were possible to write one, it could not be of any use. Therefore, all who wish to overcome the difficulties of painting from Nature must persevere under continual practice until they become quite familiar with their colours, and know, in short, the full extent of their capabilities. When this has been acquired, together with a readiness of execution, there need not be any embarrassment in finding a subject to paint from. The motive that guided us in this lesson has been to direct the attention of our pupils to other subjects besides that of landscape, from which may be derived many valuable

lessons upon colouring. We know of none better capable of helping them in their studies than those which are usually termed "still life"; their variety affords abundant choice, in which both form and colour may be studied with equal advantage. Fruits, flowers, vegetables, articles of ornament and dress, culinary utensils, and numberless other objects, insignificant perhaps in themselves, possess great value in the eyes of an artist, who is open to receive instruction from whatever source it may be obtained. There are times and seasons when it would be impossible to seek our subjects out of doors, and on these occasions we must depend upon something we can place upon the table; and although our model may not be of the class to enable us to produce a picture of very high art, it may, nevertheless, afford us some valuable instruction, and on that account it must not be despised.

ELOCUTION.—V.

[Continued from p. 287.]

IV.—CORRECT PRONUNCIATION.

THAT pronunciation is correct which is sanctioned by good usage or custom. Good usage implies the habit of persons of good education, as regulated by the decisions of learning and taste, exemplified in standard dictionaries—a style which is equally free from the errors of uneducated or negligent custom, and the caprices of pedantry—which falls in with the current of cultivated mind, and does not deviate into peculiarities on the mere authority of individuals. Good taste in pronunciation, while it allows perfect freedom of choice as to the mode of pronouncing words liable to variation in sound or accent, requires a compliance with every fixed point of sanctioned usage.

The subject of pronunciation, like the preceding one—articulation—belongs properly to the department of elementary instruction. But as this branch of elocution does not always receive its due share of seasonable attention, many errors in pronunciation are apt to occur in the exercise of reading, as performed by even the advanced classes in schools. To avoid such errors, it will be found useful to discuss, closely and minutely, the correct pronunciation of every word which in any lesson is liable to be mispronounced, the standard of reference being any good dictionary of the English language.

V.—TRUE TIME.

By true time in elocution is meant an utterance well-proportioned in sound and pause, and neither too fast nor too slow. We should never read so fast as to render our reading indistinct, nor so slow as to impair the vivacity, or prevent the full effect, of what is read.

Everything tender or solemn, plaintive or grave, should be read with great moderation. Everything humorous or sprightly, everything witty or amusing, should be read in a brisk and lively manner. Narration should be generally equable and flowing; vehemence, firm and accelerated; anger and joy, rapid; whereas, dignity, authority, sublimity, reverence, and awe, should, along with deeper tone, assume a slower movement. The movement should in every instance be adapted to the sense, and free from all hurry on the one hand, or drawling on the other. The pausing, too, should be carefully proportioned to the movement or rate of the voice; and no change of movement from slow to fast, or the reverse, should take place in any clause, unless a change of emotion is implied in the language of the piece.

The "slowest" and the "quickest" rates of utterance have been exemplified under the head of "versatility" of voice, and need not be repeated here. They occur in the extremes of grave and gay emotion.

There are three important applications of "time" in connection with "rate" or "movement" which frequently occur in the common forms of reading and speaking. These are the "slow," the "moderate," and the "lively." The first of these, the "slow," is exhibited in the tones of *awe, reverence,* and *solemnity* when these emotions are not so deep as to require the slowest movement of all. The second, the "moderate," belongs to *grave* and *serious* expression when not so deep as to require the "slow" movement; it belongs, also, to all unimpassioned communication addressed to the understanding more than to the *feelings;* and it is exemplified in the utterance of *moderate, subdued,* and *chastened emotion.* The third rate, the "lively," is perhaps sufficiently indicated by its designation, as characterising all *animated, cheerful,* and *gay expression.*

All the exercises on "time" should be repeated till they can be exemplified perfectly and at once. Previous to practising the following exercises, the student will be aided in forming distinct and well-defined ideas of "time" by turning back to the example under "versatility" marked as "very slow," and repeating it with close attention to its extreme slowness. He will observe that, in the repeating of this example, the effect of "time," or proportion of movement, is to cause a remarkable lengthening out of the sound of every accented vowel; an extreme slowness in the succession of the sounds of all letters, syllables, and words; and along with all this, an unusual length in all the

pauses. It is this adjustment of single and successive sounds and their intermissions which properly constitutes the office of "time" in elocution: although the term is often indefinitely used rather as synonymous with the word "movement," as applied in music.

The "slow" movement differs from the "slowest," in not possessing the same extreme prolongation of sound in single vowels, or the same length of pause. The slow succession of sound is, however, a common characteristic in both.

Example of "Slow" Movement.

Thou, who didst put to flight
Primeval silence, when the morning stars
Exulting shouted o'er the rising ball;
O Thou, whose word from solid darkness struck
That spark, the sun, strike wisdom from my soul!

"Moderate."

There is something nobly simple and pure in a taste for the cultivation of forest trees. It argues, I think, a sweet and generous nature to have a strong relish for the beauties of vegetation, and a friendship for the *hardy* and glorious sons of the forest. There is a grandeur of thought connected with this part of rural economy. It is worthy of liberal, and free-born, and aspiring men. He who plants an oak looks forward to future ages, and plants for posterity. Nothing can be less selfish than this. He cannot expect to sit in its shade, and enjoy its shelter; but he exults in the idea that the acorn which he has buried in the earth shall grow up into a lofty tree, and shall keep on flourishing, and increasing, and benefiting mankind long after he shall have ceased to tread his paternal fields.

"Lively."

How does the water come down at Lodore?

Here it comes sparkling,
And there it lies darkling,
Here smoking and frothing
Its tumult and wrath in,
Till, in this rapid race
On which it is bent,
It reaches the place
Of its steep descent;
The cataract strong,
Then plunges along,
Striking and raging,
As if a war waging
Its caverns and rocks among:
Rising and leaping,
Sinking and creeping,
Swelling and sweeping,
Showering and springing,
Flying and flinging,
Writhing and ringing,
Eddying and whisking,
Spouting and frisking,
Turning and twisting
Around and around,
With endless rebound;
Smiting and fighting—
A sight to delight in;
Confounding, astounding,
Dizzying and deafening the ear with its sound,
And so never ending, but always descending.
Sounds and motions for ever and ever are blending,
All at once and all o'er, with a mighty uproar;
And this way the water comes down at Lodore.

VI.—APPROPRIATE PAUSES.

The grammatical punctuation of sentences—by which they are divided into clauses by commas, although sufficiently distinct for the purpose of separating the syntactical portions of the structure—is not adequate to the object of marking all the audible pauses which sense and feeling require in reading aloud. Hence we find that intelligible and impressive reading depends on introducing many short pauses not indicated by commas or other points, but essential to the meaning of phrases and sentences. These shorter pauses are for the sake of distinction termed "rhetorical."

Powerful emotion not unfrequently suggests another species of pause, adapted to the utterance of deep feeling. This pause sometimes takes place where there is no grammatical point used, and sometimes is added to give length to a grammatical pause. This pause may be termed the "oratorical," or the pause of "effect."

The length of the rhetorical pause depends on the length of the clause, or the significance of the word which follows it. The full "rhetorical pause" is marked thus ||, the half "rhetorical pause" thus |, and the short "rhetorical pause" thus '.

Rules for "Rhetorical" Pauses.

The "rhetorical" pause takes place, as follows:—

1. Before a verb when the nominative is long, or when it is emphatic:—

Life' || is short, and art || is long.

2. Before and after an intervening phrase:—

Talents || without application || are no security for progress in learning.

3. Wherever transposition of phrases may take place:—

Through dangers the most appalling || he advanced with heroic intrepidity.

4. Before an adjective following its noun:—

Hers was a soul || replete with every noble quality.

5. Before relative pronouns, prepositions, conjunctions, or adverbs used conjunctively, when followed by a clause depending on them:—

A physician was called in || who prescribed appropriate remedies

The traveller began his journey || in the highest spirits || and with the most delightful anticipations.

6. Where ellipsis, or omission of words, takes place:—

To your elders manifest becoming deference, to your companions || frankness, to your juniors || condescension.

gentleness; in a patient bearing of injuries; in a readiness to forgive offences; in a uniform endeavour to overcome evil with good; in self-denial and disinterestedness; in universal kindness and courtesy; in slowness to wrath; in an unwillingness to hear or to speak evil of others; in a forwardness to defend, to advise, and to assist them; in loving our enemies; in blessing them that curse us; in doing good to them that hate us. These are genuine fruits of true Christianity.

LOGARITHMS.—III.

[Continued from p. 302.]

ANTILOGARITHMS.

WE now bring our lessons in "Logarithms" to a conclusion with an explanation of the term Antilogarithm, and a table of Antilogarithms.

An *Antilogarithm* plainly means *the opposite of a logarithm*—that is, *the number corresponding to any given logarithm*. The following table is arranged exactly like the former, and contains the mantissæ of all logarithms lying between ·0000 and ·9999.

As a logarithm, according to the rules laid down regarding the first table, always consists of *four figures*, and the table of antilogarithms contains no more and no less, one rule will be quite sufficient to enable the student to *take out* the number answering to any given logarithm. It is as follows:—Look for the first two figures of the mantissa of the given logarithm in the first column of the *Table of Antilogarithms*, and in the same horizontal line with these two figures, in one of the ten adjoining columns on the right, under the *third figure* of the mantissa at the top, you will find the antilogarithm answering to the *first three figures* of the mantissa. Next, in the same horizontal line with this number, in one of the nine other columns, headed *Fourth Figure*, and under the *fourth figure* of the mantissa at the top, you will find a number which is to be *added* to the antilogarithm already found, in order to make it the complete antilogarithm required. Now, according to the nature of the index of the given logarithm, by the rules laid down in our preceding lessons, point this antilogarithm—that is, mark it either as integer or decimal or mixed number, as the case may be—and you will have the *number required*.

Example.—Let it be required to find the number corresponding to the logarithm 0·1635. Here, looking for ·16 in the first column of the table, you find in the same horizontal line in one of the *ten* adjoining columns on the right, under 3 (the third figure of the mantissa) at the top, the antilogarithm 1455; and in the same horizontal line with this antilogarithm, in one of the next *nine* adjoining columns under 5 (the fourth figure of the mantissa) at the top, the number 2, which is to be added to 1455; this being done, you have 1457 for the complete antilogarithm required. Now, as the index of the given logarithm is 0, this indicates that the number must contain only one integer figure; and the antilogarithm 1457 being pointed according to this index, you have 1·457 for the *number* required.

Had the given logarithms been 1·1635, 2·1635, and 5·1635, the corresponding numbers would have been 14·57, 145·7, and 1457·09.

TABLE OF ANTILOGARITHMS.

	THIRD FIGURE.										FOURTH FIGURE.								
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
·00	1000	1002	1005	1007	1009	1012	1014	1016	1019	1021	0	0	1	1	1	1	2	2	2
·01	1023	1026	1028	1030	1033	1035	1038	1040	1042	1045	0	0	1	1	1	1	2	2	2
·02	1047	1050	1052	1054	1057	1059	1062	1064	1067	1069	0	0	1	1	1	1	2	2	2
·03	1072	1074	1076	1079	1081	1084	1086	1089	1091	1094	0	0	1	1	1	1	2	2	2
·04	1096	1099	1102	1104	1107	1109	1112	1114	1117	1119	0	1	1	1	1	2	2	2	2
·05	1122	1125	1127	1130	1132	1135	1138	1140	1143	1146	0	1	1	1	1	2	2	2	2
·06	1148	1151	1153	1156	1159	1161	1164	1167	1169	1172	0	1	1	1	1	2	2	2	2
·07	1175	1178	1180	1183	1186	1189	1191	1194	1197	1199	0	1	1	1	1	2	2	2	2
·08	1202	1205	1208	1211	1213	1216	1219	1222	1225	1227	0	1	1	1	1	2	2	2	3
·09	1230	1233	1236	1239	1242	1245	1247	1250	1253	1256	0	1	1	1	1	2	2	2	3
·10	1259	1262	1265	1268	1271	1274	1276	1279	1282	1285	0	1	1	1	1	2	2	2	3
·11	1288	1291	1294	1297	1300	1303	1306	1309	1312	1315	0	1	1	1	2	2	2	2	3
·12	1318	1321	1324	1327	1330	1334	1337	1340	1343	1346	0	1	1	1	2	2	2	2	3
·13	1349	1352	1355	1358	1361	1365	1368	1371	1374	1377	0	1	1	1	2	2	2	3	3
·14	1380	1384	1387	1390	1393	1396	1400	1403	1406	1409	0	1	1	1	2	2	2	3	3
·15	1413	1416	1419	1422	1426	1429	1432	1435	1439	1442	0	1	1	1	2	2	2	3	3
·16	1445	1449	1452	1455	1459	1462	1466	1469	1472	1476	0	1	1	1	2	2	2	3	3
·17	1479	1483	1486	1489	1493	1496	1500	1503	1507	1510	0	1	1	1	2	2	2	3	3
·18	1514	1517	1521	1524	1528	1531	1535	1538	1542	1545	0	1	1	1	2	2	2	3	3
·19	1549	1552	1556	1560	1563	1567	1570	1574	1578	1581	0	1	1	1	2	2	3	3	3
·20	1585	1589	1592	1596	1600	1603	1607	1611	1614	1618	0	1	1	1	2	2	3	3	3
·21	1622	1626	1629	1633	1637	1641	1644	1648	1652	1656	0	1	1	2	2	2	3	3	3
·22	1660	1663	1667	1671	1675	1679	1683	1687	1690	1694	0	1	1	2	2	2	3	3	3
·23	1698	1702	1706	1710	1714	1718	1722	1726	1730	1734	0	1	1	2	2	2	3	3	4
·24	1738	1742	1746	1750	1754	1758	1762	1766	1770	1774	0	1	1	2	2	2	3	3	4
·25	1778	1782	1786	1791	1795	1799	1803	1807	1811	1816	0	1	1	2	2	2	3	3	4
·26	1820	1824	1828	1832	1837	1841	1845	1849	1854	1858	0	1	1	2	2	3	3	3	4
·27	1862	1866	1871	1875	1879	1884	1888	1892	1897	1901	0	1	1	2	2	3	3	3	4
·28	1905	1910	1914	1919	1923	1928	1932	1936	1941	1945	0	1	1	2	2	3	3	4	4
·29	1950	1954	1959	1963	1968	1972	1977	1982	1986	1991	0	1	1	2	2	3	3	4	4
·30	1995	2000	2004	2009	2014	2018	2023	2028	2032	2037	0	1	1	2	2	3	3	4	4
·31	2042	2046	2051	2056	2061	2065	2070	2075	2080	2084	0	1	1	2	2	3	3	4	4
·32	2089	2094	2099	2104	2109	2113	2118	2123	2128	2133	0	1	1	2	2	3	3	4	4
·33	2138	2143	2148	2153	2158	2163	2168	2173	2178	2183	0	1	1	2	2	3	3	4	4
·34	2188	2193	2198	2203	2208	2213	2218	2223	2228	2234	1	1	2	2	3	3	4	4	5
·35	2239	2244	2249	2254	2259	2265	2270	2275	2280	2286	1	1	2	2	3	3	4	4	5
·36	2291	2296	2301	2307	2312	2317	2323	2328	2333	2339	1	1	2	2	3	3	4	4	5
·37	2344	2350	2355	2360	2366	2371	2377	2382	2388	2393	1	1	2	2	3	3	4	4	5
·38	2399	2404	2410	2415	2421	2427	2432	2438	2443	2449	1	1	2	2	3	3	4	4	5
·39	2455	2460	2466	2472	2477	2483	2489	2495	2500	2506	1	1	2	2	3	3	4	5	5
·40	2512	2518	2523	2529	2535	2541	2547	2553	2559	2564	1	1	2	2	3	4	4	5	5
·41	2570	2576	2582	2588	2594	2600	2606	2612	2618	2624	1	1	2	2	3	4	4	5	5
·42	2630	2636	2642	2649	2655	2661	2667	2673	2679	2685	1	1	2	2	3	4	4	5	6
·43	2692	2698	2704	2710	2716	2723	2729	2735	2742	2748	1	1	2	3	3	4	4	5	6
·44	2754	2761	2767	2773	2780	2786	2793	2799	2805	2812	1	1	2	3	3	4	4	5	6
·45	2818	2825	2831	2838	2844	2851	2858	2864	2871	2877	1	1	2	3	3	4	5	5	6
·46	2884	2891	2897	2904	2911	2917	2924	2931	2938	2944	1	1	2	3	3	4	5	5	6
·47	2951	2958	2965	2972	2979	2985	2992	2999	3006	3013	1	1	2	3	3	4	5	5	6
·48	3020	3027	3034	3041	3048	3055	3062	3069	3076	3083	1	1	2	3	4	4	5	6	6
·49	3090	3097	3105	3112	3119	3126	3133	3141	3148	3155	1	1	2	3	4	4	5	6	6
·50	3162	3170	3177	3184	3192	3199	3206	3214	3221	3228	1	1	2	3	4	4	5	6	7
·51	3236	3243	3251	3258	3266	3273	3281	3289	3296	3304	1	2	2	3	4	5	5	6	7
·52	3311	3319	3327	3334	3342	3350	3357	3365	3373	3381	1	2	2	3	4	5	5	6	7
·53	3388	3396	3404	3412	3420	3428	3436	3443	3451	3459	1	2	2	3	4	5	6	6	7
·54	3467	3475	3483	3491	3499	3508	3516	3524	3532	3540	1	2	2	3	4	5	6	6	7
·55	3548	3556	3565	3573	3581	3589	3597	3606	3614	3622	1	2	2	3	4	5	6	7	7
·56	3631	3639	3648	3656	3664	3673	3681	3690	3698	3707	1	2	3	3	4	5	6	7	8
·57	3715	3724	3733	3741	3750	3758	3767	3776	3784	3793	1	2	3	3	4	5	6	7	8
·58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882	1	2	3	4	4	5	6	7	8
·59	3890	3899	3908	3917	3926	3936	3945	3954	3963	3972	1	2	3	4	5	5	6	7	8
·60	3981	3990	3999	4009	4018	4027	4036	4046	4055	4064	1	2	3	4	5	6	6	7	8
·61	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	1	2	3	4	5	6	7	8	9
·62	4169	4178	4188	4198	4207	4217	4227	4236	4246	4256	1	2	3	4	5	6	7	8	9
·63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355	1	2	3	4	5	6	7	8	9
·64	4365	4375	4385	4395	4406	4416	4426	4436	4446	4457	1	2	3	4	5	6	7	8	9
·65	4467	4477	4487	4498	4508	4519	4529	4539	4550	4560	1	2	3	4	5	6	7	8	9
·66	4571	4581	4592	4603	4613	4624	4634	4645	4656	4667	1	2	3	4	5	6	7	9	10
·67	4677	4688	4699	4710	4721	4732	4742	4753	4764	4775	1	2	3	4	5	7	8	9	10
·68	4786	4797	4808	4819	4831	4842	4853	4864	4875	4887	1	2	3	4	6	7	8	9	10
·69	4898	4909	4920	4932	4943	4955	4966	4977	4989	5000	1	2	3	5	6	7	8	9	10

But the latter designates objects to the attention, or distinguishes them to the understanding, as:—

The *fall of man* is the main subject of Milton's great poem.

"Relative" emphasis occurs in words which express comparison, correspondence, or contrast, as:—

Cowards die *many* times; the *brave* but *once*.

Rules on Emphasis.

Rule 1.—Exclamations and interjections usually require "impassioned emphasis, or the strongest force of utterance, as in the following examples:—

Woe! to the traitor, WOE!
UP! comrades, UP!
AWAKE! ARISE! or be for EVER FALLEN!
Ye icefalls!
Motionless torrents! silent cataracts!
Who made you glorious as the gates of heaven,
Beneath the keen full moon?—
GOD! GOD! the torrents, like a shout of nations,
Utter: the ice-plain bursts, and answers, GOD!
The silent snow-mass, loosening, thunders, GOD!

Rule 2.—Every new *incident* in a narration, every new *object* in a description, and every new *subject* in a didactic passage, requires "distinctive" emphasis, or a force of utterance sufficient to render it striking or prominent.

Examples.

Their frail bark was, in a moment, *overset*, and a watery grave seemed to be the inevitable doom of the whole party.

The eye rested with delight on the long low range of beautifully tinted *clouds* which skirted the horizon.

The power of *faith* was the subject of the preacher's discourse.

Rule 3.—All correspondent, and all antithetic, or contrasted words, require a force sufficient to distinguish them from all the other words in a sentence, and to make them stand out prominently. When the comparison or contrast is of equal force in its constituent parts, the emphasis is exactly balanced in the words to which it is applied: when one of the objects compared or contrasted is meant to preponderate over the other, the emphasis is stronger on the word by which the preponderance is expressed.

Examples.

The gospel is preached equally to the *rich* and to the *poor*.
Custom is the *plague* of *wise* men, and the *idol* of *fools*.
The man is more KNAVE than *fool*.

Exercises in "Relative" Emphasis.

VIRTUE || is better than *riches*.
Study || not so much to *show* knowledge, as to *acquire* it.
They went out *from* us, but they were not *of* us.
He | that cannot *bear* a jest, should not *make* one.
It is not so easy to *hide* one's faults, as to *mend* them.
I | that denied thee *gold*, will give my *heart*.
You *have* done that | you *should* be sorry for.
Why beholdest thou the *mote* || that is in thy *brother's* eye, but considerest not the *beam* || that is in thine own eye?

As it is the part of *justice* || never to do *violence*, so it is the part of *modesty* || never to commit *offence*.

A *friend* || cannot be *known* || in *prosperity*, and an *enemy* || cannot be *hidden* || in *adversity*.

Emphatic clauses (those in which every word is emphatic) are sometimes pronounced on a lower, sometimes on a higher key, but always with an intense force.

Examples.

Heaven and earth will witness—
IF | ROME | MUST | FALL—that *we* || are innocent.

This state had then *not one ship*—NO, NOT | ONE | WALL.

But youth, it seems, is not my only crime: I have been accused || *of acting* a THEATRICAL *part*.

As to the *present* ministry, I cannot give them my confidence. Pardon me, gentlemen; *Confidence is a plant of* SLOW *growth*.

General Remark.—Young readers are commonly deficient in emphasis, and hence feeble and unimpressive, in their style of reading. Students should exert much vigilance on this point. At the same time, an overdone emphasis is one of the surest indications of defective judgment and bad taste. Faults which result from study are always the most offensive.

Exercise.—The Duty of a True Christian.

The true Christian must show that he is in *earnest* about religion. In the management of his *worldly affairs*, he must let it clearly be seen, that he is not influenced by a *worldly mind*; that his *heart* is not upon *earth*: that he pursues his worldly calling from a principle of DUTY, not from a sordid love of *gain*; and that, in truth, his *treasures* are in HEAVEN. He must, therefore, not only "provide things *honest* in the sight of all men"; not only *avoid* everything which is *fraudulent* and *unjust* in his dealings with others; not only *openly protest* against those *iniquitous practices* which the custom of *trade* too frequently *countenances* and *approves*; but, also, he must "let his *moderation* be known unto all men." He must not push his gains with *seeming eagerness*, even to the utmost LAWFUL extent. He must exercise *forbearance*. He must be content with *moderate* profits. He must sometimes even *forego* advantages, which, in themselves, he might innocently *take*, lest he should seem to give any ground for suspecting that his *heart* is secretly *set* upon these things.

Thus, also, with respect to *worldly pleasures*: he must endeavour to convince men that the pleasures which RELIGION furnishes are far *greater* than those which the *world* can yield. While, therefore, he conscientiously keeps from joining in those *trifling*, and too often *profane*, amusements, in which *ungodly* men profess to seek their *happiness*, he must yet labour to show, that, in keeping from those things, he is, in respect to *real* happiness, no *loser*, but even a GAINER by religion. He must *avoid* everything which may look like *moroseness* and *gloom*. He must cultivate a *cheerfulness* of spirit. He must endeavour to show, in his whole deportment, the *contentment* and *tranquillity* which naturally flow from *heavenly affections*, from a *mind* at *peace* with GOD, and from a *hope* full of IMMORTALITY.

The spirit which *Christianity* enjoins and produces is so widely different from the spirit of the *world*, and so immensely *superior* to it, that, as it cannot fail of being *noticed*, so it cannot fail of being *admired*, even by those who are *strangers* to its *power*. Do you ask in what particulars this spirit *shows* itself? I answer, in the exercises of *humility*, of *meekness*, of

En Laponie, une peau d'hermine coûte quatre ou cinq sous; la chair de cet animal sent très *mauvais*. REGNARD.	*In Lapland the skin of the ermine costs four or five sous; the flesh of this animal smells very bad.*
De ma vie je n'ai entendu des voix de femme monter si *haut*. MME. DE SÉVIGNÉ.	*Never in my life have I heard women's voices sound so loud.*

Compound adjectives remain invariable when they express colour. In other cases only their last component agrees, the first being considered as an adverb modifying the second:—

Cet oiseau a le bec et les pieds *gris-brun*. BUFFON.	*This bird's bill and feet are of a dark brown colour.*
Une fille *nouveau-née*.	*A new-born daughter.*
Des moutons *mort-nés*.	*Still-born sheep.*

PLACE OF THE QUALIFYING ADJECTIVE.

Some French adjectives are *always* placed *after* their nouns; others *always before*; others, again, *either* before *or* after, according to taste, harmony, or for the sake of emphasis. It will be understood from this that most French adjectives follow their noun.

The adjectives which are generally placed after the noun are:—

(1) Most present and all past participles used adjectively:—

Une personne *reconnaissante*,	*a grateful person.*
Une histoire *amusante*,	*an amusing history.*
Une contrée *riante*,	*a lovely scenery.*
Un enfant *chéri*,	*a beloved child.*
De la viande *rôtie*,	*roast meat.*

NOTE.—The past participle *prétendu* is the only exception to this rule.

(2) All adjectives expressing form, shape:—

Une table *ronde*,	*a round table.*
Une chambre *carrée*,	*a square room.*

(3) Adjectives expressing the matter of which an object is composed:—

Acide *sulfurique*,	*sulphuric acid.*
Corps *aérien*,	*aerial body.*

(4) Those expressing colour, taste, or physical conditions and properties:—

Un habit *noir*,	*a black coat.*
Du fruit *amer*,	*bitter fruit.*
Des sons *harmonieux*,	*harmonious sounds.*
De la cire *molle*,	*soft wax.*
De l'eau *froide*,	*cold water*
Une salle *humide*,	*a damp hall.*

(5) Adjectives which may be used substantively:—

Un homme *riche*;	*a rich man.*
Une femme *aveugle*,	*a blind woman.*

(6) Adjectives expressing nationality:—*

Une grammaire *française*,	*a French grammar.*
Un dictionnaire *allemand*,	*a German dictionary.*

* In reference to things, the French often use the name of the country instead of the adjective of nationality; particularly when speaking of the produce of the country:—

De la laine *d'Espagne*,	*Spanish wool.*
Du fromage *d'Angleterre*;	*English cheese.*

(7) Adjectives expressing the defects of the body and mind:—

Un homme *boiteux*,	*a lame man.*
Un esprit *aliéné*,	*an unsound mind.*

(8) Almost all adjectives ending in *-al*, *-able*, *-ible*, *-ique*, and *-if*:—

Un homme *libéral*,	*a liberal man.*
Une somme *considérable*,	*a considerable sum.*
Une nation *paisible*,	*a peaceful nation.*
Un esprit *fanatique*,	*a fanatical spirit.*
Un soldat *fugitif*,	*a fugitive soldier.*

(9) Adjectives of many syllables:—

Des lois *imaginaires*,	*imaginary laws.*

Those which almost always precede their noun are the following:—

Beau, *fine, handsome.*	Mauvais, *bad.*
*Bon, *good.*	Méchant, *wicked.*
*Brave, *brave.*	Meilleur, *better.*
Cher, *dear (loved).*	Moindre, *less.*
*Grand, *great, tall.*	Petit, *small.*
Gros, *large*	Saint, *holy.*
Jeune, *young.*	Vieux, *old.*
Joli, *pretty.*	

Those marked with an asterisk are included in the table given on the next page.

Most, if not all, French adjectives may be used either before or after their noun for the sake of emphasis or harmony:—

Before the Noun.	*After the Noun.*
Jamais nous ne goûtons de *parfaite* allégresse. CORNEILLE.	Qu'a-t-il dit, qu'a-t-il fait, Qui ne promette à Rome un empereur *parfait*?
We never enjoy perfect pleasure.	*What has he said, what has he done, which does not promise to Rome a perfect emperor?*
Il fallut réveiller d'un *profond* sommeil cet autre Alexandre. BOSSUET.	Dans un sommeil *profond* ils ont passé leur vie. BOILEAU.
It was necessary to rouse from a profound sleep that second Alexander.	*They spent their life in a profound sleep.*
Craignez d'un vain plaisir les *trompeuses* amorces. BOILEAU.	Le monde est une figure *trompeuse* qui passe. BUFFON.
Fear the deceitful allurements of a vain pleasure.	*The world is a deceitful picture, which passes before us.*

When several adjectives qualify one noun, they may be placed either after the noun, or one before and one after, or all before.

They are generally placed after the noun, unless they are of those which are only used before or after it:—

Un général *brave* et *habile*,	*a brave and skilful general.*

They are placed one before and one after the noun when they are of those which are only used before and after the noun:—

De *jolis* enfants *anglais*,	*pretty English children.*

They are placed all before the noun when they are of those which are only used before, and either before or after it:—

De *grands* et *terribles* événements s'ensuivirent.	*Great and terrible events followed.*

When several nouns are qualified by one of those

TABLE OF ANTILOGARITHMS (*continued*).

	THIRD FIGURE.										FOURTH FIGURE.								
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
·70	5012	5023	5035	5047	5058	5070	5082	5093	5105	5117	1	2	4	5	6	7	8	9	11
·71	5129	5140	5152	5164	5176	5188	5200	5212	5224	5236	1	2	4	5	6	7	8	10	11
·72	5248	5260	5272	5284	5297	5309	5321	5333	5346	5358	1	2	4	5	6	7	9	10	11
·73	5370	5383	5395	5408	5420	5433	5445	5458	5470	5483	1	3	4	5	6	8	9	10	11
·74	5495	5508	5521	5534	5546	5559	5572	5585	5598	5610	1	3	4	5	6	8	9	10	12
·75	5623	5636	5649	5662	5675	5689	5702	5715	5728	5741	1	3	4	5	7	8	9	10	12
·76	5754	5768	5781	5794	5808	5821	5834	5848	5861	5875	1	3	4	5	7	8	9	11	12
·77	5888	5902	5916	5929	5943	5957	5970	5984	5998	6012	1	3	4	5	7	8	10	11	12
·78	6026	6039	6053	6067	6081	6095	6109	6124	6138	6152	1	3	4	6	7	8	10	11	13
·79	6166	6180	6194	6209	6223	6237	6252	6266	6281	6295	1	3	4	6	7	9	10	11	13
·80	6310	6324	6339	6353	6368	6383	6397	6412	6427	6442	1	3	4	6	7	9	10	12	13
·81	6457	6471	6486	6501	6516	6531	6546	6561	6577	6592	2	3	5	6	8	9	11	12	14
·82	6607	6622	6637	6653	6668	6683	6699	6714	6730	6745	2	3	5	6	8	9	11	12	14
·83	6761	6776	6792	6808	6823	6839	6855	6871	6887	6902	2	3	5	6	8	9	11	13	14
·84	6918	6934	6950	6966	6982	6998	7015	7031	7047	7063	2	3	5	6	8	10	11	13	15
·85	7079	7096	7112	7129	7145	7161	7178	7194	7211	7228	2	3	5	7	8	10	12	13	15
·86	7244	7261	7278	7295	7311	7328	7345	7362	7379	7396	2	3	5	7	8	10	12	13	15
·87	7413	7430	7447	7464	7482	7499	7516	7534	7551	7568	2	3	5	7	9	10	12	14	16
·88	7586	7603	7621	7638	7656	7674	7691	7709	7727	7745	2	4	5	7	9	11	12	14	16
·89	7762	7780	7798	7816	7834	7852	7870	7889	7907	7925	2	4	5	7	9	11	13	14	16
·90	7943	7962	7980	7998	8017	8035	8054	8072	8091	8110	2	4	6	7	9	11	13	15	17
·91	8128	8147	8166	8185	8204	8222	8241	8260	8279	8299	2	4	6	8	9	11	13	15	17
·92	8318	8337	8356	8375	8395	8414	8433	8453	8472	8492	2	4	6	8	10	12	14	15	17
·93	8511	8531	8551	8570	8590	8610	8630	8650	8670	8690	2	4	6	8	10	12	14	16	18
·94	8710	8730	8750	8770	8790	8810	8831	8851	8872	8892	2	4	6	8	10	12	14	16	18
·95	8913	8933	8954	8974	8995	9016	9036	9057	9078	9099	2	4	6	8	10	12	15	17	19
·96	9120	9141	9162	9183	9204	9226	9247	9268	9290	9311	2	4	6	8	11	13	15	17	19
·97	9333	9354	9376	9397	9419	9441	9462	9484	9506	9528	2	4	7	9	11	13	15	17	20
·98	9550	9572	9594	9616	9638	9661	9683	9705	9727	9750	2	4	7	9	11	13	16	18	20
·99	9772	9795	9817	9840	9863	9886	9908	9931	9954	9977	2	5	7	9	11	14	16	18	20

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[*Continued from p. 209.*]

USE OF THE ARTICLE BEFORE WORDS TAKEN IN A PARTITIVE SENSE.

A WORD, when used to denote an entire object or class of objects, is said to have a general sense. When, however, it is employed to indicate a *part* of any thing or class of things, considered in reference to the *whole*, it is said to have a partitive sense. Before a word taken partitively, the word *some* or *any* is, or may, in English, often be employed. If, for example, we use the words *courage* and *wood* abstractedly, we take them in the general sense; but if we say, *Give me wood, Your brother has courage*, we use them in the partitive sense—that is, we ask for a part of that substance called *wood*, and attribute to your brother something of that quality called *courage*.

The article with *de* is used before nouns used in a partitive sense:—

Du pain et *de l'*eau lui suffisent.	*Bread and water are sufficient for him* (that is, *some bread and some water*)
Apportez-nous *du* sel et *du* vinaigre.	*Bring us salt and vinegar* (that is, *some salt*, etc.).

When the noun taken in a partitive sense is preceded by an adjective, *de* or *d'* is used for both genders and numbers:—

Proposons-nous à nous-mêmes *de* grands exemples à imiter, plutôt que *de* vains systèmes à suivre. J. J. ROUSSEAU.	*Let us propose to ourselves rather to imitate great examples than to follow vain systems.*

When, however, the noun preceded by the adjective is so connected with it that the two form a compound noun, this noun takes the article with *de*, according to the above rule:—

Heureux si de son temps, pour *de* bonnes raisons, La Macédoine eût eu *des petites maisons*! BOILEAU.	*Fortunate would it have been, if in his time (Alexander's) Macedonia had had lunatic asylums.*

The preposition *de* is used before a substantive preceded by a collective noun or by an adverb of quantity:—

Une multitude *de* peuples.	*A multitude of nations.*
Beaucoup *de* personnes.	*Many persons.*
A quoi bon tant *d'*amis?	*Of what use are so many friends?*
Un seul nous suffit s'il nous aime. FLORIAN.	*A single one suffices if he loves us.*

The article with *de* (*du, de la, de l', des*), however, is used when the noun, whether or not preceded by a collective noun, is taken in a limited sense. The noun **la plupart**, *the most*; the adverb of manner, *bien*, when used as an adverb of quantity, in the sense of *much, many*, also require the article* *du*, etc.:—

Un grand nombre *des* personnes que j'ai vues. NOEL.	*Many of the persons whom I have seen.*
Il me reste peu *des* livres qui m'ont été donnés. NOEL.	*I have few left of the books which have been given me.*
Les méchants ont bien *de la* peine à demeurer unis. FÉNELON.	*The wicked have much trouble to remain united.*
Ne donnez jamais *des* conseils qu'il soit dangereux de suivre. GIRAULT DUVIVIER.	*Never give advice which it is dangerous to follow.*

The words *some* or *any*, expressed or understood, are rendered by *de*, also in negative sentences:—

Je ne vous ferai pas *de* reproches.	*I shall not cast upon you any reproaches.*
L'on ne dit jamais que l'on n'a point *d'*esprit. BOURSAULT.	*We never say that we have no wit.*
On ne fait jamais *de* bien à Dieu, en faisant du mal aux hommes. VOLTAIRE.	*We never can do good in respect to God by doing evil to men.*

REPETITION OF THE ARTICLE.

GENERAL RULE.—The article † is repeated before every noun, and every word used as a noun having a separate meaning:—

Le cœur, *l'*esprit, *les* mœurs, tout gagne à la culture.	*The heart, the mind, the manners, everything improves by cultivation.*
Le père et *la* mère semblaient exciter leur petite compagne à s'en repaître la première. BUFFON.	*The father and mother seemed to excite their little companion to feed upon it first.*

The article will, therefore, be repeated when one of two adjectives, united by the conjunction *et*, qualifies a noun expressed, and the other a noun understood:—

* Before the adjective *autre*, in the plural, *bien*, as an adverb of quantity, does not require the article *du*, etc., but the preposition *de*:—**J'ai vu bien d'autres pays**, *I have seen many other countries.*

† This rule applies to the determinative adjectives, *mon, ton, son, ce, cet*, etc.

L'histoire ancienne et la moderne.	*Ancient and modern history.*

That is, *L'histoire ancienne et l'histoire moderne.*

Les philosophes anciens et les modernes	*Ancient and modern philosophers.*
Le premier et le second étage.	*The first and second storeys.*

NOTE.—In this case the noun expressed is used in the singular.

Should, however, the two adjectives qualify the same expressed word, the article must not be repeated :—

Le sage et pieux Fénelon a des droits bien acquis à l'estime générale. GIRAULT DUVIVIER.	*The wise and pious Fénelon has well-established rights to general esteem.*
À ces mots, il lui tend le doux et tendre ouvrage. BOILEAU.	*At these words he presents to him the sweet and tender book.*

When two nouns are joined by the conjunction *ou*, and the second is merely a repetition or explanation of the first, the article should not be repeated :—

Les joues ou côtés de la tête du condor sont couvertes d'un duvet noir. BUFFON.	*The cheeks or sides of the condor's head are covered with black down.*
On distinguait parmi les nobles *les palatins ou gouverneurs* des provinces. J. J. ROUSSEAU.	*They distinguished among the nobles the palatines or governors of provinces.*

REMARKS ON THE USE OF THE ARTICLE.

The article is not used before numbers placed after the names of sovereigns to designate their order of succession :—

Louis *dix-huit*, Charles *dix*.	*Louis the Eighteenth, Charles the Tenth.*

The French put no article before nouns placed in apposition with, or explanation of, other preceding nouns :—

Louis treize, *fils* de Henri quatre, fut bien différent de son père.	*Louis the Thirteenth, the son of Henry the Fourth, was very different from his father.*
Le Tartufe, *comédie* de Molière.	*The Tartufe, a comedy of Molière.*
Lamartine, célèbre *poète* et *prosateur* français.	*Lamartine, a celebrated French poet and prose-writer*
Je suis *français*, vous êtes *américain*.	*I am a Frenchman; you are an American.*

If the explanatory word is itself taken in a qualified sense, the indefinite article *un* is then placed before it :—

Cet homme est *un* Français d'une famille illustre, mais malheureuse.	*That man is a Frenchman of an illustrious but unfortunate family.*
Ces messieurs sont *des* marchands de Lyon.	*Those gentlemen are merchants from Lyons.*

In the following expressions, the nouns which are used in explanation of other nouns do not take the article :—

un montre *d'or*,	*a gold watch.*
une maître *de dessin*,	*a drawing-master.*
une moulin *à vapeur*,	*a steam-mill.*
une chambre *à coucher*,	*a bed-room.*

The following exception should be noted. The definite article is used, besides the preposition *à*, between such nouns as express the vessels, places, etc., in which commodities are generally kept or sold, and the noun expressing such commodities; but this occurs *only* when the preposition between the two nouns is *à* :—

un marché *aux* chevaux,	*a horse-fair*
la halle *au* blé,	*the corn-exchange.*
la bouteille *au* vin,	*the wine-bottle.*
le pot *au* lait,	*the milk-jug.*

Nouns referring to vessels, however, admit of being followed by the definite article *only* when they are preceded by it ; but when they follow the indefinite article, the preposition *à* alone must be used :—

le pot *au* lait,	*the milk-jug.*
un pot *à* lait,	*a milk-jug.*
la bouteille *à* l'encre,	*the ink-bottle.*
une bouteille *à* encre,	*an ink-bottle.*

Proper names of persons do not admit of the article unless it forms a part of the name: as, *Lebrun*, *Lamartine*, *La Harpe*, *La Fontaine*. As also in the names of some Italian poets and painters: as, Le Tasse, *Tasso*; Le Dante, *Dante*, etc. An adjective, however, coming before proper names, is generally preceded by the article.—

Le bon et naïf La Fontaine.	*The good and ingenuous La Fontaine*
Le pieux Fénelon.	*The pious Fénelon*

It has been seen that the plural article is often placed in elevated style before the names of renowned individuals :—

Nous avons vu à la fois à la tête des escadrons impériaux *les* Murat, *les* Kellermann, *les* Lassalle, *les* Montbrun.	*We have seen at once at the head of the imperial squadrons, Murat, Kellermann, Lassalle, Montbrun.*

Names of kingdoms and provinces, when preceded by the preposition *en*, take no article —

En France, *en* Amérique.	*In France, in America.*

No article is placed after *en* preceding a noun used indeterminately ; or after the word *ni* standing before a noun, direct object of a verb.—

Nous irons *en* voiture.	*We shall go in a carriage.*
Vous êtes *en* peine.	*You are in trouble.*
Nous n'avons *ni* or *ni* argent.	*We have neither gold nor silver.*

The article is omitted before *plus* and *moins* in comparative sentences, where, in English, it would in the corresponding place be inserted :—

Plus une action est utile, *plus* elle est louable.	*The more useful an action is, the more praiseworthy it is.*

The article precedes *plus* and *moins* to form the superlative relative, and agrees in gender and number with the noun :—

Votre sœur ne pleurait pas, quoiqu'elle fût *la plus* affligée de toutes ces dames.	*Your sister did not weep, although she was the most grieved of all those ladies.*

The article remains invariable when it stands before a superlative absolute (*i.e.*, a superlative not implying comparison with *other* persons or objects):—

Votre sœur ne pleure pas, lors même qu'elle est *le* plus affligée. NOËL.	*Your sister does not weep, even when she is most grieved.*

For the sake of emphasis, the article is often omitted before a series of nouns used either as subjects or as objects:—

Citoyens, étrangers, amis, ennemis, tous le révèrent.	*Citizens, strangers, friends, enemies—all reverence him.*

IDIOMS IN WHICH THE ARTICLE IS OMITTED.

Ajouter foi, *to give credit.*	Faire honneur, *to honour.*
Avec ardeur, etc., *with ardour.*	Faire horreur, *to inspire horror.*
Avoir appétit, *to have an appetite.*	Faire mention, *to mention.*
Avoir besoin, *to have need.*	Faire naufrage, *to suffer shipwreck.*
Avoir chaud, *to be warm.*	Faire peur, *to frighten.*
Avoir coutume, *to be accustomed*	Faire place, *to make room.*
Avoir dessein, *to intend.*	Faire plaisir, *to oblige.*
Avoir dispute, *to have difficulties*	Faire présent, *to present.*
Avoir envie, *to wish, to desire.*	Faire réflexion, *to reflect.*
Avoir faim, *to be hungry.*	Faire tort, *to injure.*
Avoir froid, *to be cold.*	Mettre fin, *to put an end.*
Avoir honte, *to be ashamed.*	Mettre ordre, *to arrange.*
Avoir mal, *to have a pain.*	Par dépit, etc., *through spite.*
Avoir patience, *to have patience.*	Perdre courage, *to lose courage.*
Avoir peur, *to be afraid.*	Porter envie, *to envy.*
Avoir pitié, *to take pity.*	Porter malheur, *to bring ill-luck.*
Avoir raison, *to be right.*	Pour récompense, etc., *as a reward.*
Avoir soif, *to be thirsty.*	Prendre congé, *to take leave.*
Avoir soin, *to take care.*	Prendre feu, *to catch fire.*
Avoir sommeil, *to be sleepy.*	Prendre garde, *to take care.*
Avoir sujet, *to have reason.*	Prendre haleine, *to take breath.*
Avoir tort, *to be wrong.*	Prendre médecine, *to take medicine.*
Chercher fortune, *to seek one's fortune.*	Prendre racine, *to take root.*
Courir risque, *to run the risk.*	Rendre compte, *to account.*
Demander justice, *to demand justice*	Rendre justice, *to render justice.*
Demander pardon, *to beg pardon.*	Rendre service, *to oblige.*
Donner avis, } *to inform.*	Rendre visite, *to visit.*
Faire part, }	Sans peine, *without difficulty.*
Entendre raillerie,* *to bear jokes.*	Sans souci, *without sorrow or care.*
Faire attention, *to pay attention.*	Tenir compagnie, *to keep company.*
Faire bonne chère, *to live well.*	Tenir lieu, *to take the place.*
Faire crédit, *to sell on credit.*	Tenir parole, *to keep one's word.*
Faire envie, *to excite envy.*	Trouver moyen, *to find means.*

THE ADJECTIVE.

We have already seen that an adjective relating to two substantives of the same gender must agree with them in gender, and be put in the plural;

And that an adjective relating to two or more nouns of different genders must be put in the masculine plural.

When, however, nouns not united by the conjunction *et* are somewhat synonymous; when the writer wishes to draw the attention more especially to the last—the adjective will assume the gender and number of the last noun only:—

Toute sa vie n'a été qu'un travail, qu'une occupation *continuelle.* MASSILLON.	*His whole life has been nothing but continual labour and occupation.*
Je ne connais point de roman, point de comédie *espagnole* sans combats. FLORIAN.	*I know no Spanish novel or comedy without combats.*
Le fer, le bandeau, la flamme est toute *prête.* RACINE	*The knife, the band, the flame is all ready.*

* *Entendre la raillerie* is also said, but it means, *To understand joking.*

Sometimes the adjective preceded by two or more substantives joined by the conjunction *et* is intended to qualify the last only. It must then, of course, agree with that noun only:—

Le bon goût des Égyptiens leur fit aimer la solidité et la régularité toute *nue.* BOSSUET.	*The good taste of the Egyptians made them like solidity and unadorned regularity.*
Le sourire est une marque de bienveillance, d'applaudissement, et de satisfaction *intérieure.* BUFFON.	*The smile is a mark of good-will, of applause, and of inward satisfaction.*

REMARKS ON THE PECULIARITIES OF SEVERAL ADJECTIVES.

The adjective feu, *late, deceased*, is invariable when placed before the article or adjective determining a noun, but varies when placed after the determining word:—

J'ai ouï dire à *feu* ma sœur, que sa fille et moi naquîmes la même année. MONTESQUIEU.	*I have heard my late sister say that her daughter and I were born the same year.*
Le duc de . . . doit à la bienveillance dont l'honorait la *feue* reine, les bonnes grâces de l'empereur. DE SALVANDY.	*The duke of . . . owes to the good-will of the late queen towards him the good graces of the emperor.*
Feu les princes (or les *feus* princes).	*The late princes.*

NOTE.—*Feu* is said only of persons we have or might have known. When applied to kings, popes, etc., it means the last one, who has died: *Feu la reine* is employed when no queen has succeeded the defunct one; *la feue reine*, in the reverse case.

The adjectives nu, *bare*, and demi, *half*, are invariable when placed before the noun, in which case they are joined to it by a hyphen:—

Il était *nu*-tête; les pieds chaussés de petites sandales. VOLTAIRE.	*He was bare-headed; he wore on his feet small sandals.*
Une *demi*-heure après avoir quitté le vaisseau, je foulai le sol américain. CHATEAUBRIAND.	*Half an hour after having left the ship, I trod the American soil.*

The adjectives *nu* and *demi* when coming after the noun agree with it:—

Accoutumez vos enfants à demeurer été et hiver, jour et nuit, toujours tête *nue.* J. J. ROUSSEAU.	*Accustom your children to remain summer and winter, day and night, always bare-headed.*
Opimius paya la tête de Caius Gracchus, dix-sept livres et *demie* d'or. VERTOT.	*Opimius paid for the head of Caius Gracchus seventeen pounds and a half of gold.*

Franc, in the expression franc de port, *postage free, carriage paid*, may be used adjectively, when it must agree; or adverbially, when it remains invariable:—

J'ai reçu *franc de port* une lettre anonyme. J. J. ROUSSEAU.	*I received, postage free, an anonymous letter.*
Le Contrat social est imprimé, et vous en recevrez douze exemplaires, *francs de port.* J. J. ROUSSEAU.	*The Social Contract is printed, and you will receive twelve copies free of postage.*

An adjective used adverbially—that is, modifying a verb—is of course invariable:—

However, when *tout* precedes an adjective or past participle feminine beginning with a consonant or sounded *h*, it agrees in gender and number:—

Les plaisanteries ne sont bonnes que quand elles sont servies *toutes* chaudes. VOLTAIRE.	*Jokes are only good when they are served up quite warm.*
La vanité est sortie *toute* parée de la tête des femmes comme Minerve est sortie *tout* armée de la tête de Jupiter. SAINT-LAMBERT.	*Vanity issued all adorned from woman's head, as Minerva issued all armed from the head of Jupiter.*

BOTANY.—XX.

[*Continued from p. 293.*]

MONOCOTYLEDONS.

HAVING now briefly passed in review the chief orders of Dicotyledons, we come to the second class of angiosperms, in descending order, the *Monocotyledones*. The characters by which these plants are, as a whole, distinguished from dicotyledons, and the sub-classes, series, and cohorts in which they are grouped, have been stated in Vol. IV., pp. 355–6. Referring back to that lesson, we see that Monocotyledons have only one cotyledon; have as a rule no tap-root; have numerous closed fibro-vascular bundles, but no distinct pith or separable bark to the stem; have parallel-veined leaves and the parts of the flower in threes. Though there are various exceptions, the typical floral formula of the whole class is 3.3.3+3.(3). (*See* Vol. IV., p. 37.) The class is subdivided into two sub-classes, mainly by the character of the perianth, the *Petaloideæ* and the *Nudifloræ*. The *Petaloideæ* have a perianth, which is usually in two trimerous whorls, one, or both, of which is commonly petaloid, whilst both stamens and carpels occur generally in the same flower. They are divided into the two series, *Epigynæ*, with an inferior, and *Hypogynæ*, with a superior ovary. Of these the Epigynæ contains the five cohorts, *Narcissales*, *Orchidales*, *Amomales*, *Dioscorales*, and *Hydrales*.

The cohort *Narcissales* contains the two orders, *Amaryllideæ* and *Irideæ*. The *Amaryllideæ* are a large order, chiefly consisting of bulbous herbs with linear leaves, flowers sometimes monosymmetric, stamens from six to eighteen in number, with introrse anthers and a three-chambered, many-seeded fruit, either a berry or capsular. The typical formula is 3.3.3+3.$(\overline{3})$. The order is most abundant in South Africa. *Agave*, the magueys or Mexican aloes, are monocarpic perennials, forming large stems crowned by rosettes of fleshy spinous leaves, the veins of which are valuable as fibre. The fermented liquor, pulque, is prepared from the sugary sap of the buds. After several years they send up a branched flowering stem and die from the physiological exhaustion of producing a number of flowers and fruits, whence they have been exaggeratingly called century plants. They differ from true aloes, which belong to the *Liliaceæ*, in having an inferior ovary. In the daffodil (*Narcissus Pseudo-Narcissus*) and other species of the genus *Narcissus*, and in some other genera, there is a *coronet* or tubular outgrowth from the perianth-tube; and in this genus, in the snowdrop (*Galanthus*), and in other cases, the flowers are enclosed, when young, in a more or less membranous spathe or sheathing bract.

The *Irideæ* are herbs with bulbs, corms, or rhizomes; distichous, equitant, linear leaves; flowers, sometimes monosymmetric; stamens, only three in number, the inner whorl being suppressed, so that the carpels are superposed upon the existing ones; the anthers extrorse; the style often dividing into three petaloid divisions, and the fruit three-chambered and capsular. The formula (*see* Vol. IV., p. 37) is 3.3.3.1$(\overline{3})$ or 3.3.3+0.$(\overline{3})$. Like the Amaryllideæ the order is abundant in South Africa. *Iris* has a dichasial rhizome which in one species, *I. florentina*, yields the perfumed orris-root. The flower is polysymmetric, the outer perianth-segments or sepals being commonly reflexed and sometimes furnished with a median fringe or beard, whilst the large petaloid style-segments spread over the stamens, each having a stigmatic line above the anther, this latter throwing its pollen on to the beard. *Crocus* has a corm, and a subterranean ovary. The stigmatic lobes of the style in *C. sativus* and others furnish saffron; but the plant must not be confounded with the liliaceous, and therefore six-stamened, *Colchicum*, misleadingly called autumn crocus or meadow saffron. *Gladiolus* is monosymmetric.

The cohort *Orchidales* includes but the one large and remarkable order, the *Orchidaceæ*. This order comprises several thousand species in about 400 genera, which are all herbaceous, and, though occurring in almost all countries, are most numerous in tropical forests. Some are rootless; others, such as the British bird's-nest orchis (*Neottia nidus-avis*), are brown, without chlorophyll or true leaves, being saprophytes, living upon decaying leaves; and many of the tropical forms are epiphytic, growing on the branches of trees. *Vanilla*, the aromatic placenta of which is almost the sole useful product of the order, is a tropical climber. Our British terrestrial species commonly have tuberculate roots (*see* Vol. III., p. 113 and Fig. 27), and the tropical epiphytes have green aërial roots, sometimes with a peculiar spongy epithelial outer layer or *velamen* of spirally thickened cells. They commonly have also stem-tubers or *pseudo-bulbs*. The

adjectives which are only used before their noun, the adjective is repeated before each:—

De *grands* crimes et de *grands* excès accompagnèrent la Revolution.	*Great crimes and great excesses attended the Revolution.*

Finally many adjectives, especially when they are used in reference to persons, have a different meaning according as they precede or follow certain nouns. They are the following:—

Un *bon* homme, *a simple, artless man.*	Un homme *bon*, *a good, benevolent man* (un homme de bien).
Un *brave* homme, *a worthy man.*	Un homme *brave*, *a brave man.*
Une *certaine* histoire, *a certain story.*	Une histoire *certaine*, *a reliable story.*
Un *cher* enfant, *a dear child.*	Une robe *chère*, *an expensive dress.*
Une *commune* voix, *a unanimous voice.*	Une voix *commune*, *an ordinary voice.*
Un *cruel* homme, *a tiresome man.*	Un homme *cruel*, *a cruel man.*
La *dernière* année, *the last year* (*of a series*)	L'année *dernière*, *last year.*
Une *fausse* clef, *a false key; a skeleton key.*	Une clef *fausse*, *a key belonging to another lock* (*the wrong key*).
Un *furieux* menteur, *an excessive liar.*	Un lion *furieux*, *a furious lion.*
Un *galant* homme, *a gentleman.*	Un homme *galant*, *a man attentive to the ladies.*
Un *grand* homme, *a great man.*	Un homme *grand*, *a tall man.*
Le *grand* air, *the air of good society.*	L'air *grand*, *a noble appearance.*
Le *haut* ton, *a haughty tone.*	Le ton *haut*, *a loud tone.*
Un *honnête* homme, *an honest man.*	Un homme *honnête*, *a polite man.*
Le *jeune* Pline, *young Pliny.*	Pline *le jeune*, *Pliny the younger.*
Un *malhonnête* homme, *a dishonest man.*	Un homme *malhonnête*, *an impolite man.*
Mauvais air, *awkward appearance.*	L'air *mauvais*, *malicious appearance.*
Un *méchant* livre, *a poor book.*	Un livre *méchant*, *a biting, caustic book.*
Morte eau, *neap-tides.*	Eau *morte*, *stagnant water.*
Un *nouveau* livre, *a new book* (*another book*).	Un livre *nouveau*, *a book recently published.*
Nul homme n'est parfait, *no man is perfect*	Un homme *nul*, *a man who is but a cypher, a fool.*
	Un testament *nul*, *a will that is void.*
Un *pauvre* historien, *a wretched historian.*	Un historien *pauvre*, *an historian without pecuniary means.*
Un *plaisant* homme, *a ridiculous man.*	Un homme *plaisant*, *an agreeable man.*
Un *petit* homme, *a short man.*	Un homme *petit*, *a mean man.*
Mes *propres* mains, *my own hands.*	Mes mains *propres*, *my clean hands.*
Un *seul* enfant, *an only child.*	Un enfant *seul*, *a child alone.*
Un *simple* soldat, *a private soldier.*	Un soldat *simple*, *a foolish soldier.*
Un *triste* homme, *a pitiful man.*	Un homme *triste*, *a sorrowful man.*
Un *unique* tableau, *a single picture.*	Un tableau *unique*, *a matchless picture.*
Un *vilain* homme, *an ugly, unpleasant man.*	Un homme *vilain*, *a sordid, miserly man.*
Une *vraie* histoire, *a mere story, a fib*	Une histoire *vraie*, *a true history.*

COMPLEMENT OF ADJECTIVES.

The complement of an adjective is a noun or a verb completing or defining its sense. Between the noun and the adjective comes one of the prepositions *à*, *de*, *dans*, *en*, *sur*, etc.:—

Cet homme est digne *de louange.*	*This man is worthy of praise.*
Ce général est digne *de commander.*	*That general is worthy to command.*

In the first phrase, *louange*, in the second, *commander*, is the complement of the adjective *digne*.

The complement is not indispensable to the adjective. It is added to it only to give it a certain definite sense:—

Without a complement.	*With a complement.*
Cet homme n'est pas content.	Cet homme n'est pas content *de son fils.*
That man is not pleased.	*That man is not pleased with his son.*

As may be seen in the last sentence, an adjective is not always, in French, followed by the same preposition as the corresponding adjective in English. Thus, after the adjective *content*, the French use the preposition *de* (*of*), whilst after its English equivalent (*pleased*), the preposition *with* must be employed; in order therefore to help the student out of this difficulty we have given, besides lists of adjectives requiring the prepositions *de*, *à*, and others, the following rules.

When an adjective follows the verb *être*, *used impersonally*, the preposition *de* is placed after that adjective, and before the verb following:—

Il est beau *de* mourir pour son pays.	*It is noble to die for one's country.*
Il est plus aisé d'être sage pour les autres que pour soi-même. LA ROCHEFOUCAULD.	*It is easier to be wise for another than for oneself.*
Il est plus glorieux *de* se vaincre soi-même, que *de* vaincre les autres. SCUDÉRY.	*It is more glorious to conquer oneself than to conquer others.*

It should be recollected that it is only when the verb *être* is impersonal that it requires the preposition *de*. In other cases the adjective must be followed by the preposition proper to it:—

Cela est beau *à* voir.	*That is beautiful to see.*
Cela n'est pas aisé *à* faire.	*That is not easy to be done* (*easily done*).

Adjectives expressing feelings of kindness or unkindness to men or animals generally require the preposition *envers*:—

Il est affable *envers* tout le monde.	*He is affable to everybody.*
Il faut être charitable *envers* les pauvres, et poli *envers* tout le monde.	*We must be charitable to the poor, and civil to everybody.*
Ne soyez pas cruel *envers* les animaux.	*Do not be cruel to animals.*

LIST OF ADJECTIVES REQUIRING THE PREPOSITION *de*.

Absent de, *absent* (*from*).	Différent de, *different from.*
Ambitieux de, *ambitious of.*	Digne de, *worthy of, to.*
Amoureux de, *in love with.*	Envieux de, *envious of.*
Avide de, *eager for.*	Esclave de, *a slave to.*
Capable de, *capable of, to.*	Exempt de, *exempt from.*
Complice de, *accomplice in.*	Fier de, *proud of.*
Content de, *pleased with.*	Fort de, *confident in.*
Curieux de, *curious to.*	Fou de, *excessively fond of.*
Dédaigneux de, *disdaining to.*	Glorieux de, *proud of.*
Désireux de, *desirous to, of.*	Honteux de, *ashamed of.*

Impatient de, *impatient of.*	Plein de, *full of.*
Incapable de, *incapable of.*	Ravi de, *glad to, of.*
Inconsolable de, *inconsolable for.*	Reconnaissant de, *grateful for.*
Indigne de, *unworthy of.*	Redevable de, *indebted for.*
Indigné de, *indignant with.*	Soigneux de, *careful of, to.*
Inquiet de, *uneasy about.*	Sûr de, *sure of.*
Ivre de, *intoxicated with.*	Tributaire de, *tributary to.*
Las de, *weary of*	Victime de, *victim of, to.*
Mecontent de, *displeased with.*	Vide de, *void of.*

Qui vit content *de* rien, possède toute chose. — *He who lives content with a little possesses all.*

BOILEAU.

Il n'est pas de Romain,
Qui ne soit désireux *de* vous donner la main. — *There is no Roman that is not desirous to reach you his hand.*

CORNEILLE.

LIST OF ADJECTIVES REQUIRING THE PREPOSITION *à*.

Accessible à, *accessible to.*	Formidable à, *formidable to.*
Adhérent à, *adhering to.*	Impénétrable à, *impenetrable to.*
Agréable à, *agreeable to.*	Indispensable à, *indispensable to.*
Aisé à, *easy to.*	Insensible à, *insensible to.*
Antérieur à, *prior to.*	Invisible à, *invisible to.*
Ardent à, *zealous for.*	Naturel à, *natural to.*
Assidu à, *assiduous for.*	Nécessaire à, *necessary to.*
Attentif à, *attentive to.*	Nuisible à, *hurtful to.*
Bon à, *good for.*	Odieux à, *odious to.*
Cher à, *dear to.*	Postérieur à, *posterior to.*
Conforme à, *similar to.*	Préférable à, *preferable to.*
Contraire à, *contrary to.*	Propice à, *propitious to.*
Difficile à, *difficult to.*	Propre à, *fit for.*
Enclin à, *prone to.*	Rebelle à, *rebellious towards.*
Etranger à, *a stranger to.*	Redoutable à, *formidable to.*
Exact à, *exact in.*	Semblable à, *similar to.*
Facile à, *easy to.*	Sujet à, *subject to.*
Fatal à, *fatal to*	
Favorable à, *favourable to.*	

L'ignorance toujours est prête *à* s'admirer. BOILEAU. — *Ignorance is always ready to admire itself.*

Insensible *à* la vie, insensible *à* la mort,
Il ne sait quand il veille, il ne sait quand il dort. — *Insensible to life, insensible to death, he does not know when he is awake, or when he sleeps.*

RACINE.

ADJECTIVES REQUIRING A DIFFERENT PREPOSITION IN FRENCH AND IN ENGLISH, NOT INCLUDED IN THE ABOVE LIST.

Bon pour, *kind towards, devoted to.*	Ignorant en, *ignorant of.*
Célèbre pour, par, *celebrated for.*	Indulgent pour, *indulgent towards.*
	Insolent avec, *insolent to.*

Quand on est bon *pour* tout le monde, on ne l'est *pour* personne. C. DELAVIGNE. — *When one is devoted to everybody, one is so towards nobody.*

Il fut célèbre *par* sa doctrine, autant que *par* sa naissance. BOSSUET. — *He was celebrated for his doctrine, as well as for his birth.*

RULES ON THE CONSTRUCTION OF ADJECTIVES WITH DIFFERENT PREPOSITIONS.

A noun may be followed by two or more adjectives having one and the same complement, provided those adjectives require the same prepositions after them. Thus we may say:—

Ce père est utile et cher *à* sa famille. GIRAULT DUVIVIER. — *That father is useful and dear to his family.*

La religion est nécessaire et naturelle *à* l'homme. ANONYMOUS. — *Religion is necessary and natural to man.*

These two sentences are correct, because the adjectives *utile* and *cher* in the first, and *nécessaire* and *naturel* in the second, require the same preposition *à*.

We could not, in the first of these two sentences, substitute the adjective chéri, *beloved*, for the word *cher*, and say, as in English, *That father is useful* TO, *and beloved* BY, *his family*. Such a construction in French *is never admissible*. We must say, *That father is useful to his family, and is beloved by them;* because the adjective *chéri* requires the preposition *de*, or its substitute, the relative pronoun *en**;— *Ce père est utile à sa famille et en est chéri.*

DETERMINATIVE AND DEMONSTRATIVE ADJECTIVES.

The demonstrative adjective, which must not be confounded with the demonstrative pronoun, always precedes the noun, and must be repeated before every substantive. It assumes the gender and number of the word which it determines:—

Cet air pur, *ces* gazons, *cette* voûte mobile:
Ici tout plait au cœur, tout enchante les yeux. CARTEL. — *That pure air, that turf, that changing vault, here everything pleases the heart and charms the eyes.*

AGREEMENT, REPETITION, AND PLACE OF THE POSSESSIVE ADJECTIVE.

We have said that the possessive adjective assumes the gender and number of the object possessed, and that it must be repeated before every noun. The place of the possessive adjective is the same in French as in English—that is, before the noun. These adjectives must not be confounded with the possessive pronouns:—

Mon père, *ma* mère, et *mes* sœurs sont arrivés — *My father, mother, and sisters have arrived.*

REMARKS ON THE POSSESSIVE ADJECTIVES.

It has been said that the French use the article instead of the possessive adjective when alluding to the parts of the body. This, however, must only take place where the possession is otherwise sufficiently explained. We must say, for instance—

J'ai mal à *la* tête. — *My head aches (I have a pain in the head).*

Charles *s'est* cassé *le* bras. — *Charles has broken his arm.*

because the possession is sufficiently explained by the pronouns *je* in the first instance, and *se* in the second. But we must say—

Je vois que *mon* bras enfle. — *I see that my arm swells.*

because, without *mon*, the possessor of the arm would not be indicated.

The English expressions, *a friend of mine, a cousin*

* The rule with regard to the object of verbs is equally imperative. We could not say in French, as in English, *Every week I write letters* TO, *and receive letters* FROM, *my brother*. We must say, *Every week I write letters to my brother, and receive some from him:* Toutes les semaines j'écris des lettres *à* mon frère, et j'en reçois *de* lui.

of his, cannot be translated literally into French. We must say, **Un de mes amis**, *one of my friends;* **un de ses cousins**, *one of his cousins*:—

Cinna ét Carbon, *un de ses lieutenants*, se campèrent sur les bords du Tibre. VERTOT.	*Cinna and Carbo, a lieutenant of his, encamped on the banks of the Tiber.*

In familiar or jocose style, we sometimes use the possessive pronoun, *mien, tien, sien*, without the article, to express the same relation:—

À travers d'un *mien* pré, certain anon passa. RACINE.	*Through a meadow of mine a young ass passed.*
Un *mien* cousin est juge-maire. LA FONTAINE.	*A cousin of mine is judge and mayor.*

When the possessor is an inanimate object, the adjectives *son, sa, ses, leur, leurs* can be placed before the object possessed only when the possessor and the thing possessed appear in the same clause:—

La campagne a *ses* agrements.	*The country has its pleasures.*
Ces langues ont *leurs* beautes	*Those languages have their beauties.*

When the *inanimate* possessor is not the subject of the clause in which the possession is expressed, but of a preceding one, the article and the relative pronoun *en* are used:—

Ce livre est bien imprimé; *le* papier *en* est excellent	*That book is well printed; its paper is excellent.*
J'habite la campagne; *les* agrements *en* sont sans nombre.	*I inhabit the country; its pleasures are without number.*
Ces langues sont riches; *j'en* admire *les* beautes. NOEL.	*Those languages are rich; I admire their beauties.*

Exception.—The possession may be expressed by *son, sa, ses, leur, leurs*, although the possessor is not the subject of the same clause, when the thing possessed is the complement of a preposition:—

Paris est une ville remarquable; les etrangers admirent *la* beaute de *ses* edifices. NOEL.	*Paris is a remarkable city; foreigners admire the beauty of its buildings.*

NUMERAL ADJECTIVES.

The cardinal number, used simply to indicate number, not order, precedes the noun.

When used to indicate order, the cardinal number generally follows the noun, except when indicating the day of the month.—

Leon *dix*.—Chapitre *dix*.	*Leo the Tenth.—Chapter ten.*

The ordinal number is generally placed before the noun:—

La *dixième* année.	*The tenth year.*

But it follows the words *chapitre, livre, article, page*, etc, in the division of books, agreements, etc:—

Livre *sixième*, chapitre *dixième*.	*Sixth book, tenth chapter.*

INDEFINITE ADJECTIVES.

Quelque is written in three ways:—

(1) Followed by the verb *être*, it is written in two words, *quel que*. *Quel*, which is an adjective, agrees in gender and number with the subject; and *que*, which is a conjunction, is invariable. In this case the verb is used in the subjunctive, and its subject placed after it:—

Mais *quels que* soient ton culte et ta patrie, Dors sous ma tente avec sécurité. CAMPENON.	*But, whatever may be thy religion or thy country, sleep in security under my tent.*
Cet homme, *quelle que* fût sa fortune ou son merite, ne put reussir dans ses entreprises. BONIFACE.	*That man, whatever his fortune or his merit might be, could not succeed in his undertakings.*

(2) Followed by a noun, the object of a verb, it is an adjective, and agrees in number with that noun:—

Princes, *quelques* raisons que vous puissiez me dire. RACINE.	*Princes, whatever reasons you may give me.*

(3) *Quelque*, followed by an adjective, a past participle, or an adverb, is an adverb, and therefore invariable:—

Les jeux de hasard, *quelque* médiocres qu'ils paraissent, sont toujours chers et dangereux. MME. DE GENLIS.	*Games of chance, however trifling they may seem, are always expensive and dangerous.*

Même is an adjective or an adverb.

It is an adjective—

(1) When it precedes the noun, and means *same*:—

Vous retombez toujours dans les *mêmes* alarmes. RACINE.	*You always fall into the same apprehensions.*

(2) When it follows a noun or pronoun, and has the sense of *self, even, very*, and cannot be turned into **de la même manière**, *in the same manner*:—

Les dieux eux-*mêmes* devinrent jaloux des bergers. FÉNELON.	*The gods themselves became jealous of the shepherds.*
Ces murs *mêmes*, seigneur, peuvent avoir des yeux. RACINE.	*These very walls, my lord, may have eyes.*

It is an adverb, and therefore invariable, when it modifies a verb, an adjective, or a participle. It has then the sense of **aussi**, *also, even;* **quoique**, *although;* or **de la même manière**, *in the same manner*:—

Frappez, Tyriens et *même* Israélites. RACINE.	*Strike, Tyrians and Israelites also.*
Leurs vertus et *même* leurs noms etaient ignores. BERNARDIN DE ST. PIERRE.	*Their virtues, as well as their names, were unknown.*
Exempts de maux réels, les hommes s'en forment *même* de chimeriques.	*When exempt from real misfortune, men create for themselves (even) imaginary ones.*

Tout, when an adjective—that is, when it signifies *every, all*—is invariable.

Tout, when it means *entirely, quite, nothing but*, is an adverb, and, as such, is invariable:—

Le lion est *tout* nerfs et muscles. BUFFON.	*The lion is nothing but nerves and muscles.*
Il montra pour rimer des chemins *tout* nouveaux. BOILEAU.	*He showed us, in poetry, paths entirely new.*
Le chien est *tout* zèle, *tout* ardeur, *tout* obeissance. BUFFON.	*The dog is nothing but zeal, ardour, and obedience.*

flowers may he solitary or in an indefinite, bracteate inflorescence: they are often inverted by the twisting of the inferior ovary, which must not be mistaken for a pedicel and they are monosymmetrio, the odd sepal being strictly anterior. The three outer perianth-leaves are generally petaloid and normal; hut the two anterior petals are commonly reduced and often form a sort of hood, whilst the third is ourlously modified in size, form, and coloor, forming a lip or *labellum*. It often resembles the body of an insect and freqoently has a spur, sometimes of great length, secreting honey, not in its cavity, but within its tissues. The essential organs are nnited into a oolnmn or *gynostemium*, and, though fibro-vascular bnndles of six stamens can he traced, in most cases only one stamen, the anterior one of the outer whorl, is developed. In the lady's-slipper (*Cypripedium*) this stamen is barren, and the two anterior stamens of the inner whorl are polliniferous (*see* Vol. IV., p. 87). The one fertile anther is commonly bilooular, the pollen-grains being collected together in groups or *massulæ*, and these united by threads into two stalked clnb-shaped masses, or *pollinia*, one in each loculus. The stalk or *caudicle* of the pollinium ends in a sticky gland or *retinaculum*, which is enclosed in a pouch-like outgrowth from the style called the *bursicle*. Below this, at the mouth of the spur, is the stigmatio surface. (*See* Vol. IV., p. 117, and Fig. 58, p. 185.) In some cases the flowers are monœcious or polygamous, differing remarkahly in external form thongh on the eame plant. Pollination is mainly effacted by insects, the retinacula sticking to their heads so that the entire pollinia are removed and a few massnlæ torn off on the stigma of the next blossom visited. The bee orchis (*Ophrys apifera*), however, pollinates itself, the caudicles swaying forward in the wind. The ovary has three parietal placentas on which the ovules do not originate till pollination. They are numerous, arise, hke triohomes, from single epidermal oells, and oonsist only of embryo-sac and two integuments, forming a seed with a thin loose testa, no albnmen, and, when ripe, no distinct cotyledon or radicle.

The cohort *Amomales*, differing from most orchids in having a trilocular ovary witb central placentation and abundant perisperm to its seeds, contains four orders, *Musaceæ*, *Cannaceæ*, *Marantaceæ*, and *Zingiberaceæ*, the monosymmetrio or asymmetric flowers of whioh present ohvious resemblances to orchids and irises. Thus, whilst *Orchis* has the formnla $\downarrow 3.3.1+0.(\overline{3})$ and Cypripedium $\downarrow 3.3.\dagger 1+2.(\overline{3})$, *Musa*, the banana, is $\downarrow 3.3.3+2.(\overline{3})$, *Canna* is $3.3.0+1\dagger 2.(\overline{3})$, *Maranta*, tbe arrow-root, is $\downarrow 3.3.\dagger 3+1\dagger 2.(\overline{3})$, and *Zingiber*, the ginger, also $\downarrow 3.3.\dagger 3+1\dagger 2.(\overline{3})$, differing in the fertile anther being posterior instead of lateral as in *Maranta*. In *Amomales* the aborted stamens are represented by petaloid organs. The rhizomes of various members of the gronp yield arrow-root, a pure starch; those of *Curcuma*, belonging to the *Zingiberaceæ*, furnish the yellow colouring-substance, turmeric; whilst thoss of the gioger itself are valued from the agreeable resin they contain. The fibre of the petioles of *Musa textilis* is Manilla hemp, whilst bananas and plantains, the sugary and starchy fruits of *M. sapientum* and *M. paradisiaca*, are among the chief food-snbstances of the tropics.

The cohort *Dioscerales*, in which the flowers are polysymmetrio and the formula is typical, $3.3.3+3.(\overline{3})$ includes the orders *Dioscoreaceæ* and *Bromeliaceæ*. *Dioscorea*, the yams of the tropios, twinlog plants, with starohy tubers, exceptionally net-veined leaves, and diœcious flowers, are represented in England by *Tamus communis*, the black bryony, familiar from its cordate leavss which turn bronze-purple in autumn. Of the *Bremeliaceæ*, mostly tropical epiphytes, with orowded dry or fleshy leaves, the pineapple (*Ananas sativus*), a native of America, in whioh the baccate ovaries of a whole inflorescence coalesce with a fleshy stem into an infruitescence, is the best known.

The cohort *Hydrales*, inoluding the one order *Hydrocharidaceæ*, are water-plants with exalbuminous seeds and usually diœcious flowers with two or more trimerous whorls of stamens and sometimes of carpels. *Vallisneria spiralis* (*see* Vol. II., p. 272, Fig. 9), oommon in fresh-water aquaria, which has its pistillate flowers on long spiral pednnoles, whilst its staminate ones break their pedunoles and float, and *Elodea canadensis*, the troublesome American water-weed of our canals (*see* Vol. II., p. 272, Fig. 10), of whioh only pistillate plants occur in England, are both noticeable as exhibiting rotation of protoplasm in their leaves (*see* Vol. II., p. 274).

The series *Hypogynæ*, with a superior ovary, falls into two sub-series, the *Syncarpæ*, with three united carpels, and the *Apocarpæ*, whioh have commonly more than three carpels and no cohesion between them. The former of these includes the cohort *Liliales* and the comparatively unimportant *Commelynales*. The *Liliales* have a calyx and corolla of the same texture, albuminous seeds, and the typical formula $3.3.3+3.(3.)$ The cohort includes the orders *Liliaceæ*, with polysymmetric petaloid perianths, and the *Juncaceæ*, differing mainly in their dry glnmaceous perianth.

The *Liliaceæ*, a large and widely distributed order, include plants of very various general habit or appearance. Many in temperats climates are

bulbous herbs, such as the hyacinths, lilies, squills, onions, and tulips, or have corms, as in *Colchicum*. Others, such as *Paris*, *Asparagus*, Solomon's seal (*Polygonatum*) and lily-of-the-valley (*Convallaria*), have rhizomes; whilst some sub-tropical forms are arborescent, with woody stems, increasing in diameter by the formation of new fibro-vascular bundles in a merismatic zone of fundamental tissue, as in the dragon-tree (*Dracæna*) and in *Yucca*, or having also, as in *Aloë*, the thick fleshy leaves characteristic of dry regions. The bulbs of *Lilium* are squamose; those of *Allium*, tunicate. Bulbils are produced in the axils of the upper leaves of the tiger-lily (*Lilium bulbiferum*), and among the pedicels of the umbellate cymes of some species of *Allium*. *Ruscus aculeatus*, the butcher's-broom or knee-holly, the only British monocotyledon with a woody stem, branches copiously, its ultimate branches, in the axils of minute scale-like leaves, being flattened leaf-like phylloclades with a spinous apex, bearing the diœcious flowers or scarlet fruit. In the nearly related *Asparagus*, the edible fleshy shoots which spring from the rhizome branch freely, the phylloclades being acicular, but bearing small unisexual flowers and a fruit like that of *Ruscus*. The leaves may be linear as in *Hyacinthus*; broad, as in *Tulipa*; tubular and hollow, as in onions; fleshy, as in *Aloë*; or rigid, with strong phloem in their veins, as in the New Zealand flax (*Phormium tenax*). Herb Paris (*Paris quadrifolia*) gets its name from the Latin *par*, equal, from having four leaves in a true whorl and also an exceptionally tetramerous flower, its formula being 4.4.4+4.(4), and these foliage leaves, and those of *Smilax*, the sarsaparillas, have, like *Dioscoreaceæ*, the net-veined character of dicotyledons. *Smilax* has also stipular tendrils. The leaves of the perianth may be free or coherent. The order falls into three sub-orders: *Lilieæ*, with introrse anthers, united styles and a loculicidal capsule, including *Lilium*, *Tulipa*, *Hyacinthus*, *Scilla*, *Allium*, *Yucca*, *Aloë*, etc.; *Colchiceæ*, with extrorse anthers, separate styles and a septicidal capsule (*see* Vol. IV., p. 256), including *Colchicum autumnale*; and *Asparagineæ*, with introrse anthers, styles either free or coherent, a nuculane, and flowers sometimes dimerous or tetramerous or diclinous, including *Asparagus*, *Ruscus*, *Paris*, *Smilax*, *Convallaria*, *Polygonatum*, etc. It is important to notice that *Aloë*, a native of Africa and Arabia, differs from the Amaryllidaceous *Agave*, or so-called Mexican aloe, which it so much resembles in external habit, in having a superior ovary; and similarly that *Colchicum*, though called meadow saffron or autumn crocus, differs from the true Iridaceous *Crocus* in having six stamens and a superior ovary. Many members of the order *Liliaceæ* furnish powerful drugs.

The *Juncaceæ* include the genus *Juncus*, the rushes, many species of which have cylindric leaves and branches with stellate fundamental tissue, and *Luzula*, the wood-rushes, with a tricarpellary and three-seeded, but unilocular ovary. The cymose inflorescence is termed an *anthela*.

The sub-series *Apocarpæ* includes the one cohort *Alismales*, marsh or water plants, having in some cases unisexual flowers, and with a mere rudiment of metasperm even in the unripe seed. In the two chief orders, *Alismaceæ*, including *Alisma*, the water-plantains, and *Sagittaria*, the arrow-head, and *Butomaceæ*, including *Butomus*, the "flowering rush," the flowers have generally a green calyx and a petaloid corolla, an outer whorl of three bifurcate stamens, the inner whorl being either suppressed or indefinitely multiplied, and six or indefinite carpels. The formula is, therefore, $3.3.3^{\times 2}+3,0$ or $\infty.\underline{3+3}$ or $\underline{\infty}$. The orders differ in *Alismaceæ* having only one or two ovules in each carpel, whilst in *Butomaceæ* they are indefinite in number and, as in *Nymphæaceæ* and *Papaveraceæ*, are superficial in placentation (*see* Vol. IV., p. 185).

We come next in order to the sub-class *Nudifloræ*, in which the ovary is always superior, and the flowers may be either bisexual or unisexual, but the perianth is either absent or is reduced to mere scales. It is divided into two very distinct series, the *Glumifloræ* and the *Spadicifloræ*. Of these, the first-named derives its name from the stiff, chaff-like bracts or glumes with which its flowers, individually and in spikelets, are invested. They all have metasperm in the seed. The series *Glumifloræ* includes two cohorts, the *Restiales* and the *Glumales*, with the latter of which we need only concern ourselves. This cohort, which comprises the two large orders, *Cyperaceæ* and *Gramineæ*, familiarly known as sedges and grasses respectively, is characterised by possessing an ovary which, though generally bi-, or tri-, carpellary, is unilocular and contains one erect ovule.

Between the *Cyperaceæ* and the *Gramineæ* there are several noteworthy distinctions, amounting in fact to marked contrasts. The stems of sedges are generally solid, whilst those of most grasses have hollow internodes: the leaves of sedges are tristichous and have tubular sheaths, whilst those of grasses are distichous and have the sheath in the form of a tube split down the side opposite to that on which the blade is attached; and the usually three-angled and tricarpellate caryopsis in sedges has the embryo at the base, but surrounded by metasperm, whilst the caryopsis of grasses is usually bicarpellate, and the embryo lies at one side of its base. Finally

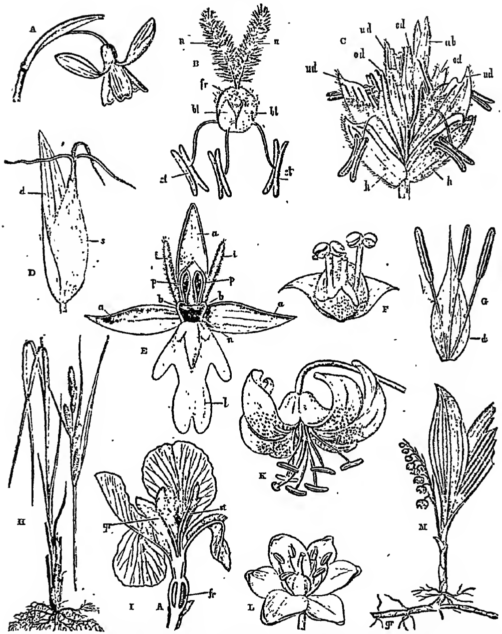

Fig. 89.—A. Flower of Snowdrop (*Galanthus nivalis*) with spathe. B. Flower of Wheat (*Triticum*): *bl*, lodicules; *st*, stamens; *fr*, ovary; *n*, stigmas. C, Spikelet of Wheat: *h*, outer glumes; *nd*, flowering glumes; *od*, paleæ; *ab*, barren flower. D, Female flower of Sedge (*Carex*): *d*, glume; *s*, utricle. E, Flower of Fly Orchis (*Ophrys muscifera*); *a*, sepals; *i*, petals; *l*, labellum; *p*, pollen-sacs; *b*, bursicles; *n*, stigma. F, Inflorescence of Duckweed (*Lemna*). G, Male Flower of Sedge: *d*, glume. H, Plant of Sedge. I, Flower of *Iris germanica* in section: *st*, stamen; *fr*, ovary; *gr*, style. K, Flower of Turk's-Cap Lily (*Lilium Martagon*). L, Flower of Squill (*Scilla maritima*). M, Lily of the Valley (*Convallaria Majalis*): *gr*, rhizome.

OBSERVATION (2).—

$R = 20$ ohms.

$G = 10$ „

Substituting these figures in the formula we get

$$B = \frac{2}{10}(20 - 2) = 2$$

$$= 1{\cdot}6 \text{ ohms.} \qquad \textit{Answer.}$$

Amperemeter and Voltmeter Method. — Two observations are necessary, and we require a high-resistance voltmeter and a low-resistance amperemeter, both capable of measuring the quantities with which we are dealing, and which are connected up as shown in Fig. 47.

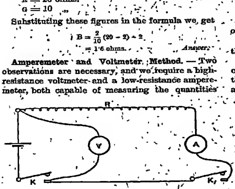

Fig. 47.

The voltmeter is marked V, the amperemeter is marked A; there are two keys in circuit, K and K_1, and R is an adjustable resistance, whose value need not be known.

OBSERVATION (1) —Depress the key K, and the reading on the voltmeter V gives a measure of the E.M.F. of the battery.

OBSERVATION (2). — Still keeping the key K depressed, depress the key K_1, and take simultaneous readings on the *voltmeter* V; and the amperemeter A.

Let E = the reading on the voltmeter in (1).

„ V = „ „ „ „ (2).

„ C = „ „ „ amperemeter in (2).

Then,

$$B = \frac{E - V}{C}.$$

This is not only a convenient method for measuring the resistance of cells, but it will also measure the resistance of any other form of current generator.

EXAMPLE 4. — Ten Grove cells in series were connected up as shown in Fig. 47, and the following observations were made:—

OBSERVATION (1).—

$E = 19{\cdot}4$ volts.

OBSERVATION (2).—

$V = 10{\cdot}2$ volts, $C = 4$ amperes.

Substituting these figures in the above formula we get

$$B = \frac{19{\cdot}4 - 10{\cdot}2}{4}$$

$$= 2{\cdot}3 \text{ ohms.} \qquad \textit{Answer.}$$

or ·23 ohms for each cell.

Mance's Method.—One observation required with the connections, as shown in Fig. 48.

With the above connections and the key up, the current on leaving the battery circulates through the different resistances as indicated by the arrows, and as a portion of this current is permanently

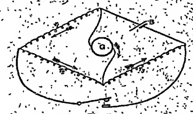

Fig. 48.

circulating through the galvanometer, there is necessarily a permanent deflection on the galvanometer. It may be well to mention that in this test, as in all the previous ones, it may be necessary to have a shunt on the galvanometer so as to alter its sensitiveness if required. If the key is now depressed, there may or may not be a change in the deflection of the galvanometer; if there is a change, then the resistances r_1, r_2, and r_3 must be adjusted till they attain values such that when the key is depressed there is *no change in the deflection* of the galvanometer. When this state of things has been arrived at, then

$$B = \frac{r_1 \times r_2}{r_3}.$$

The most accurate method of working is to make r_1 as small as possible, r_2 as large as possible, and then to adjust r_3 till the desired state of things has been arrived at.

The truth of the above formula can be verified by simplifying the following two equations, which represent the state of things when the key is up, and when it is down:—

C represents the current flowing through the galvanometer, and has the same value in both cases.

When the key is up—

$$C = \frac{E}{B + r_3 + \frac{(r_1 + r_2)\,G}{r_1 + r_2 + G}} \times \frac{r_1 + r_2}{r_1 + r_2 + G}$$

When the key is depressed, the manner in which

there is a considerable contrast in utility, the *Gramineæ* being by far the most useful to man of all natural orders, but the *Cyperaceæ* including few economic products.

In *Cyperaceæ*, the perianth is either absent, or is represented by bristles (*setæ*) or hairs. In *Eriophorum*, the cotton-grass of our moors, these hairs elongate into a tuft of wool. The flowers are sometimes bisexual, with the formula 3.3.3 + 0 or 3.($\underline{3}$), or, as in *Carex*, the large genus including the true sedges, unisexual. These latter have no perianth, and have the male and female flowers in distinct spikes or even diœcious. The anthers are commonly basifixed with parallel lobes, and the ovary is enclosed in a two-notched tubular sheath called the *perigynium* or *utriculus*, representing two confluent bracteoles. The sedges grow mainly in marshy situations, have harsh foliage, affording poor pasturage, contain but little sugar or starch, and do not lend themselves to improvement by cultivation. From the stems of *Cyperus Papyrus*, an African species, the paper of the ancients was prepared.

The order *Gramineæ* includes some 4,500 species in 250 genera. Some *Gramineæ* reach the dimensions of trees, the rapidly growing bamboos of the tropics (*Bambusa* and *Arundinaria*) having hard stems, rich in silica, with hollow internodes, often several feet each in length, which are applied to an endless variety of uses. The sugar-cane (*Saccharum officinarum*), probably native to tropical Asia, has shorter internodes, and maize (*Zea Mays*), and other grasses have also stems rich in sugar. Alfa or Esparto grass, a paper material, is *Macrochloa tenacissima*. The leaves of most grasses and some sedges have a *ligule* or scale at the junction of the sheath with the linear blade, there being as a rule no distinct petiole. Many of the smaller grasses grow "socially," especially in the north temperate zone, forming pastures, their fully developed foliage being dried into hay. The inflorescences consist of variously grouped spikelets, each enclosed in glumes and consisting of both sterile and fertile flowers. The glumes often terminate in a spinous process or *awn*. Each flower is enclosed in an *outer* or *flowering glume* and an *inner glume* or *pale*, which latter has two lateral veins, thus probably representing two confluent bracteoles. Both these organs are below the flower, and so do not represent perianth-leaves. Within them are commonly two, or in *Bambusa* three, small scales called *lodicules*, which may represent a corolla. Though maize has monœcious inflorescences, stamens and carpels generally both occur in one flower. The stamens are commonly three in number, but six in *Bambusa* and in the rice (*Oryza sativa*); have weak capillary filaments; and versatile, dorsifixed anthers with diverging lobes, often red or violet in colour and exserted. The ovary, though trilobed in *Bambusa*, which thus has the formula 0.3.3 + 3.($\underline{3}$), and monocarpellary in *Nardus*, usually has one deep longitudinal groove and two styles with feathery stigmas, showing it to be bicarpellate and, often at least, wind-pollinated. The usual formula is, therefore, 0.2.3 + 0.($\underline{2}$). The fruit or *caryopsis* is characterised by having its thin pericarp adherent to the coats of the one seed which thus fills its cavity. The copious starchy metasperm of the cereals, wheat (*Triticum vulgare*), oats (*Avena sativa*), barley (*Hordeum vulgare*), rye (*Secale cereale*), rice, maize, and the millets—several of which have been cultivated from prehistoric times—containing a good deal of nitrogenous and phosphatic matter, especially in the outer layers of the seed, renders them the most valuable articles of human food. By artificially stimulated germination or malting, much of their starch becomes sugar, from which alcoholic liquors are commonly brewed or distilled.

The series *Spadicifloræ* include the three cohorts *Palmales*, *Arales*, and *Potamales*, the first of which contains the order *Palmaceæ*, which comprises 1,000 species and in utility is second only to the *Gramineæ*. Palms are woody plants, having in early life a tap root, and a stem usually unbranched, sometimes reaching 250 feet in height. The wood of many is used in building, that of the cocoa-nut (*Cocos nucifera*) being known as porcupine-wood. *Sagus*, the sago, and others, contain much starch in the fundamental tissue of the trunk, and the sugary sap of many kinds is fermented. The terminal leaf-bud or "cabbage" is also eaten in the case of several. The leaves are often enormous and tear in a palmate or pinnate manner, being used for thatch and furnishing valuable fibres. The membranous spathe of the date (*Phœnix dactylifera*) is used in packing oranges. The inflorescence is commonly a branched fleshy spadix bearing large numbers of generally unisexual flowers, with a two-whorled perianth and six stamens or three united carpels. The ovary, however, is usually one-chambered and one-seeded. The fruit varies considerably, being more or less drupaceous. The date is fleshy with a hard seed miscalled a "stone"; the oil palm (*Elais guineensis*) has an oily mesocarp, largely used in soap and candle manufactures; the cocoa-nut has a fibrous mesocarp and a dense endocarp, or "shell," filled by the seed, with brown testa, fleshy metasperm, a large central vacuole containing milky sap, and a small embryo; and *Phytelephas* has the dense metasperm known as vegetable ivory. Palms are mostly tropical. *Chamærops humilis*, the fan-palm, being the only European species.

The cohort *Arales* includes the orders *Pandaneæ*, the screw-pines, with their leaves in a screw-like spiral; the *Typhaceæ*, the reed-maces or bulrushes; the *Lemnaceæ* or duckweeds; and the *Aroideæ*. The *Typhaceæ* have monœcious inflorescences without spathes, the female below the male. *Sparganium*, the bur-reed, has the flowers in spherical heads and a scaly perianth. *Typha*, the reed-mace, has a cylindrical mass of female flowers, their perianths being long hairs forming a velvet-like pile, and the staminate flowers being on a tapering appendage above.

Lemna, the chief genus of the *Lemnaceæ*, has a floating leaf-like stem, giving off roots with prominent root-caps from its margin, branching, and occasionally bearing two male flowers, each consisting of one stamen, and one female one, enclosed in a spathe. *Wolffia arrhiza*, the smallest of flowering plants, has neither roots, spathe, nor vascular tissue.

The *Aroideæ*, an order mainly tropical, comprising more than 1,000 species, are usually herbaceous perennials, with a rhizome or corm, starchy and sometimes of large size. Some species are climbing plants or epiphytes. The leaves are convolute, glabrous, net-veined, like those of dicotyledons, commonly sagittate, with a sheathing petiole, and sometimes perforated. The inflorescence is an unbranched scape forming a spadix, enclosed in a large sheathing spathe, bearing flowers usually achlamydeous and monœcious, and sometimes terminated by an axis or *appendix*, which is bare of flowers. The fruit is a nuculane. Most plants of the order are acridly poisonous. *Richardia æthiopica*, the "trumpet-lily," with a white spathe and spadix covered with yellow anthers, and *Anthurium Scherzerianum*, the "flamingo-flower," with scarlet spathe and twisted orange spadix, are familiar greenhouse plants. The British *Arum maculatum*, the cuckoo-pint, or "lords-and-ladies," has a pale green spathe, within which, as in other members of the order, the temperature rises considerably before it unfolds. At the base of the spadix are female flowers, each consisting merely of a monocarpellary ovary with sessile stigma. Above these are some barren ovaries with styles; above them the male flowers, each a single stamen with a four-chambered porous anther; and above them some staminodes; the whole ending in a club-shaped, yellow or purple, starchy appendix, which disappears in the fruit stage. From the corm Portland arrow-root used to be prepared.

The cohort *Potamales*, including the one order *Naiadeæ*, consists of lowly aquatic plants, some of which, such as *Zostera*, the grass-wrack, are marine. *Potamogeton*, the pond-weeds, with various types of floating and submerged leaves, have spikes of bisexual flowers, having the formula $[2.2.2+2.]\times 4$, the anthers being epiphyllous. *Naias* is more reduced, having diœcious achlamydeous flowers each of a single stamen or carpel.

PLANE TRIGONOMETRY.—III.

[*Continued from p. 311.*]

FUNDAMENTAL PRINCIPLES, ETC.

XI. *The Fundamental Formulæ.* — We have hitherto examined only the relations between ratios of the same angle; we proceed now to trace the relations between ratios of two or more different angles. The number of formulæ expressing these relations may be extended almost at will, but they are all derived from the following formulæ for the sines and cosines of the sum and difference of two angles, known, therefore, as *the four fundamental formulæ*:—

$$\sin.(A+B) = \sin. A \cos. B + \cos. A \sin. B \ldots (33)$$
$$\sin.(A-B) = \sin. A \cos. B - \cos. A \sin. B \ldots (34)$$
$$\cos.(A+B) = \cos. A \cos. B - \sin. A \sin. B \ldots (35)$$
$$\cos.(A-B) = \cos. A \cos. B + \sin. A \sin. B \ldots (36)$$

where A and B are any angles whatever.

These formulæ may be thus expressed in words:—

(33) *The sine of the sum of two angles is equal to the sine of the first into the cosine of the second plus the cosine of the first into the sine of the second.*

(34) *The sine of the difference of two angles is equal to the sine of the first into the cosine of the second minus the cosine of the first into the sine of the second.*

(35) *The cosine of the sum of two angles is equal to the product of their cosines minus the product of their sines.*

(36) *The cosine of the difference of two angles is equal to the product of their cosines plus the product of their sines.*

To prove (33).—In Fig. 8 let A O B = A, and

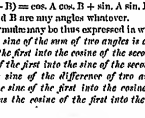

Fig. 8

B O C = B; then A O C = A + B. In this case the sum of the angles exceeds one right angle, but the same construction and lettering hold good if the sum be taken as less than 90°, though the figure will be differently arranged.

In O C take any point, P, and from it draw P Q,

PR, perpendicular to AO (produced) and to BO. From R draw RT and RS perpendicular to PQ and AO.

$$\text{Sin.}\,(A+B) = \frac{PQ}{OP} = \frac{QT+PT}{OP}$$

$$= \frac{QT}{OP} + \frac{PT}{OP} = \frac{RS}{OP} + \frac{PT}{OP} = \frac{RS}{OR}\cdot\frac{OR}{OP} + \frac{PT}{PR}\cdot\frac{PR}{OP}.$$

Since the triangles TPR and ORS are equiangular, $\frac{PT}{PR} = \frac{OS}{OR}$.

$$\therefore \sin.\,(A+B) = \frac{RS}{OR}\cdot\frac{OR}{OP} + \frac{OS}{OR}\cdot\frac{PR}{OP}$$

$$= \sin.\,A\cos.\,B + \cos.\,A\sin.\,B.$$

To prove (34).—Let AOB (Fig. 9) = A, and BOC = B; then AOC = A − B.

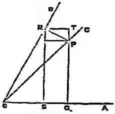

Fig. 9.

In OC take any point P, and draw the perpendiculars PQ, PR, and RS, RT, as before (RT to PQ produced).

$$\text{Sin.}\,(A-B) = \frac{PQ}{OP} = \frac{QT-PT}{OP} = \frac{QT}{OP} - \frac{PT}{OP}$$

$$= \frac{RS}{OP} - \frac{PT}{OP} = \frac{RS}{OR}\cdot\frac{OR}{OP} - \frac{PT}{PR}\cdot\frac{PR}{OP}.$$

Since the triangles TPR and ORS are equiangular, $\frac{PT}{PR} = \frac{OS}{OR}$.

$$\therefore \sin.\,(A-B) = \frac{RS}{OR}\cdot\frac{OR}{OP} - \frac{OS}{OR}\cdot\frac{PR}{OP}$$

$$= \sin.\,A\cos.\,B - \cos.\,A\sin.\,B.$$

The above proofs evidently hold good only when neither of the two angles exceeds a right angle.

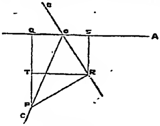

Fig. 10.

They can, however, be extended to angles of any size by precisely similar construction, which will, however, result in figures of very different appearance, according to the quadrants in which the angles are situated. In the demonstrations *the minus sign belonging to sines and cosines in certain quadrants* (*see* Section VIII.) must be borne in mind.

For instance, prove (33), in the case where A and B are both greater than right angles, but where A + B is less than three right angles. Let AOB in Fig. 10 = A, and BOC = B. In OC take any point P as before, and construct exactly as directed in the proof for (33).

Then, since A and B together form an angle in the third quadrant, whose sine is a minus quantity—

$$\text{Sin.}\,(A+B) = -\frac{PQ}{OP} = \frac{-QT-PT}{OP} = -\frac{QT}{OP} - \frac{PT}{OP}$$

$$= -\frac{RS}{OP} - \frac{PT}{OP} = -\left(\frac{RS}{OR}\cdot\frac{OR}{OP}\right) - \left(\frac{PT}{PR}\cdot\frac{PR}{OP}\right).$$

Now A and B being both angles in the second quadrant, their sines are both *plus*, and their cosines *minus* quantities.

$$\therefore \frac{RS}{OR} = \sin.\,A, \text{ for } AOR = BOQ;\ \frac{OR}{OP} = -\cos.\,B.$$

$$\frac{PT}{PR} = \frac{OS}{OR} = -\cos.\,A;\ \text{and } \frac{PR}{OP} = \sin.\,B;$$

$$\therefore \sin.\,(A+B) = -(\sin.\,A \times -\cos.\,B) - (-\cos.\,A \times \sin.\,B) = \sin.\,A\cos.\,B + \cos.\,A\sin.\,B.$$

Again, prove (34), where A is a trigonometrical angle in the fourth quadrant, B an angle in the

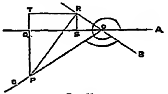

Fig. 11.

second quadrant, and their difference an angle in the third quadrant.

Let AOB in Fig. 11 = A, and BOC = B; ∴ AOC = (A − B). Construct as before—

$$\text{Then } \sin.\,(A-B) = -\frac{PQ}{OP} = -\frac{PT-QT}{OP} = \frac{QT}{OP}$$

$$-\frac{PT}{OP} = \frac{RS}{OP} - \frac{PT}{OP} = \frac{RS}{OR}\cdot\frac{OR}{OP} - \frac{PT}{PR}\cdot\frac{PR}{OP}.$$

$$\text{But } \frac{RS}{OR} = -\sin.\,A, \text{ for } ROS = AOB;\ \frac{OR}{OP} = -\cos.\,B;$$

$$\frac{PT}{PR} = \frac{OS}{OR} = \cos.\,A;\ \text{and } \frac{PR}{OP} = \sin.\,B;$$

$$\therefore \sin.\,(A-B) = \sin.\,A\cos.\,B - \cos.\,A\sin.\,B.$$

These cases will probably convince the student that (33) and (34) hold good for *all* values of A and B, as can, indeed, be proved separately, in the

same way, for every value. As practice, the student should prove the following cases:—

EXERCISE 3.

1. Prove (33), where A is an angle in the third, and B an angle in the first quadrant, but where A + B reaches to the fourth quadrant.

2. Prove the same where both A and A + B are in the third quadrant (which, of course, implies that B is less than a right angle).

3. Prove (34), when A exceeds 180°, but is less than 270°, and when B exceeds 90°, but is less than 180°. Construct the figure on the supposition that A is so near 270°, and B so much less than 180°, that A − B falls in the second quadrant. Also construct it so that A − B shall be less than 90°.

4. Prove (34), when A is an angle in the fifth quadrant, and when B = 180°. In this example A O B must, of course, be drawn as an angle in the first quadrant, and since B O C = 180°, B O and O C are in line with each other. P Q is therefore the only other line in the construction before given which it is possible to draw. A − B = the (trigonometrical) angle A D C in the third quadrant.

$$\text{Then sin. } (A - B) = -\frac{PQ}{OP} = -\text{sin. } A;$$

since P O Q = A O B, and sin. A is naturally positive

This agrees with (34), where, if we substitute the values of sin. and cos., 180°, as given in Sect. VIII., we get—

$$\text{Sin. } (A - B) = (\text{sin. } A \times -1) - (\text{cos. } A \times 0) = -\text{sin. } A.$$

5. Prove (34), where A = 180° and B exceeds 90°.

(35) and (36) can also be proved geometrically. (35) can, however, be proved more shortly, thus—

Since sin. A = cos. (90° − A), and *vice versâ*;

$$\text{Cos. } (A + B) = \text{sin. } \big(90° - (A + B)\big)$$

$$= \text{sin. } \big((90° - A) - B\big).$$

Whence, by (34).

$$\text{Cos. } (A + B) = \text{sin. } (90° - A) \text{ cos. } B - \text{cos. } (90° - A) \text{ sin. } B = \text{cos. } A \text{ cos. } B - \text{sin. } A \text{ sin. } B.$$

To prove (36):—

$$\text{Cos. } (A - B) = \text{sin. } \big(90° - (A - B)\big)$$

$$= \text{sin. } \big((90° - A) + B\big)$$

$$= \text{sin. } (90° - A) \text{ cos. } B + \text{cos. } (90° - A) \text{ sin. } B$$

$$= \text{cos. } A \text{ cos. } B + \text{sin. } A \text{ sin. } B.$$

(34) can also be derived from (33) by substituting − B for B in (33). The student should work this out, remembering that sin − B = − sin. B, but cos − B = cos B.

XII. *Formulæ for the Sum and Difference of the Sines and Cosines of the Sum and Difference of two Angles.*—By adding together (33) and (34), we obtain—

$$\text{Sin. } (A + B) + \text{sin. } (A - B) = 2 \text{ sin. } A \text{ cos. } B \ldots (37)$$

By subtracting (34) from (33)—

$$\text{Sin. } (A + B) - \text{sin. } (A - B) = 2 \text{ cos. } A \text{ sin. } B \ldots (38)$$

By adding (35) and (36)—

$$\text{Cos. } (A + B) + \text{cos. } (A - B) = 2 \text{ cos. } A \text{ cos. } B \ldots (39)$$

By subtracting (36) from (35)—

$$\text{Cos. } (A + B) - \text{cos. } (A - B) = -2 \text{ sin. } A \text{ sin. } B \ldots (40)$$

XIII. *Formulæ for the Sum and Difference of the Sines and Cosines of two Angles:*—

$$\text{Sin. } A = \text{sin. } \left(\frac{A + B + A - B}{2}\right)$$

$$= \text{sin. } \left(\frac{A + B}{2} + \frac{A - B}{2}\right).$$

$$\therefore \text{ by (33), sin. } A = \text{sin. } \frac{A + B}{2} \text{ cos. } \frac{A - B}{2}$$

$$+ \text{ cos. } \frac{A + B}{2} \text{ sin. } \frac{A - B}{2}.$$

$$\text{Similarly, sin. } B = \text{sin. } \left(\frac{A + B}{2} - \frac{A - B}{2}\right)$$

$$= \text{sin. } \frac{A + B}{2} \text{ cos. } \frac{A - B}{2} - \text{cos. } \frac{A + B}{2} \text{ . sin. } \frac{A - B}{2}.$$

Adding these results together, we get—

$$\text{Sin. } A + \text{sin. } B = 2 \text{ sin. } \frac{A + B}{2} \text{ . cos. } \frac{A - B}{2} \ldots (41)$$

Or, subtracting one from the other—

$$\text{Sin. } A - \text{sin. } B = 2 \text{ cos. } \frac{A + B}{2} \text{ . sin. } \frac{A - B}{2} \ldots (42)$$

Similarly, by adding and subtracting like expressions for cos. A and cos. B, we get—

$$\text{Cos. } A + \text{cos. } B = 2 \text{ cos. } \frac{A + B}{2} \text{ . cos. } \frac{A - B}{2} \ldots (43)$$

$$\text{Cos. } A - \text{cos. } B = -2 \text{ sin. } \frac{A + B}{2} \text{ . sin. } \frac{A - B}{2} \ldots (44)$$

XIV. *Relations between Sines, Cosines, and Tangents of two Angles.*—Dividing (33) by (35), we have—

$$\text{Tan. } (A + B) = \frac{\text{sin. } A \text{ cos. } B + \text{cos. } A \text{ sin. } B}{\text{cos. } A \text{ cos. } B - \text{sin. } A \text{ sin. } B}.$$

Dividing both numerator and denominator on the right-hand side by cos. A cos. B, we have—

$$\text{Tan. } (A + B) = \frac{\dfrac{\text{sin. } A}{\text{cos. } A} + \dfrac{\text{sin. } B}{\text{cos. } B}}{1 - \dfrac{\text{sin. } A}{\text{cos. } A} \cdot \dfrac{\text{sin. } B}{\text{cos. } B}};$$

$$\therefore \text{ tan. } (A + B) = \frac{\text{tan. } A + \text{tan. } B}{1 - \text{tan. } A \text{ tan. } B} \ldots (45)$$

Similarly, dividing (34) by (36), and again dividing the numerator and denominator by cos. A cos. B, we obtain—

$$\text{Tan. } (A - B) = \frac{\text{tan. } A - \text{tan. } B}{1 + \text{tan. } A \text{ tan. } B} \ldots\ldots (46)$$

Again, dividing (41) by (42), we obtain—

$$\frac{\text{Sin. } A + \text{sin. } B}{\text{Sin. } A - \text{sin. } B} = \frac{2}{2} \cdot \frac{\text{sin. } \frac{1}{2}(A + B)}{\text{cos. } \frac{1}{2}(A + B)} \cdot \frac{\text{cos. } \frac{1}{2}(A - B)}{\text{sin. } \frac{1}{2}(A - B)}$$

$$= \text{tan. } \tfrac{1}{2}(A + B) \text{ cot. } \tfrac{1}{2}(A - B);$$

$$\therefore \text{ since cot. } \tfrac{1}{2}(A - B) = \frac{1}{\text{tan. } \frac{1}{2}(A - B)},$$

$$\frac{\text{sin. } A + \text{sin. } B}{\text{sin. } A - \text{sin. } B} = \frac{\text{tan. } \frac{1}{2}(A + B)}{\text{tan. } \frac{1}{2}(A - B)} \ldots\ldots (47)$$

Or, *the sum of the sines of two angles is to the difference of their sines as the tangent of half their sum is to the tangent of half their difference.*

Similarly, by dividing (43) by (44)—

$$\frac{\text{Cos. } A + \cos. B}{\text{Cos. } A - \cos. B} = \frac{\cot. \frac{1}{2}(A + B)}{\tan. \frac{1}{2}(A - B)} \ldots\ldots (48)$$

XV. *Formulæ for the Ratios of the Sum of three Angles* may be obtained simply by splitting up the three into two, which can then be dealt with by formulæ already given; thus—

$$\text{Sin. } (A + B + C) = \sin. \big(A + (B + C)\big)$$
$$= \sin. A \,.\, \cos. (B + C) + \cos. A \,.\, \sin. (B + C)$$
$$= \sin. A\ (\cos. B \cos. C - \sin. B \sin. C)$$
$$+ \cos. A\ (\sin. B \cos. C + \cos. B \sin. C).$$

Whence, by a slight change in order—

$$\left.\begin{aligned}\text{Sin. } (A + B + C) = \sin. A \cos. B \cos. C \\ + \sin. B \cos. A \cos. C + \sin. C \cos. A \\ \cos. B - \sin. A. \sin. B \sin. C\end{aligned}\right\} \ldots (49)$$

By similar reasoning—

$$\left.\begin{aligned}\text{Cos. } (A + B + C) = \cos. A \cos. B \cos. C \\ - \cos. A \sin. B \sin. C - \cos. B \sin. A \\ \sin. C - \cos. C \sin. A \sin. B\end{aligned}\right\} \ldots (50)$$

Dividing (49) by (50), and the numerator and denominator of the fraction thus obtained by cos. A cos. B cos. C, we obtain—

$$\text{Tan. } (A + B + C) =$$

$$\left.\frac{\tan. A + \tan. B + \tan. C - \tan. A \tan. B \tan. C}{1 - \tan. A \tan. B - \tan. A \tan. C - \tan. B \tan. C}\right\} (51)$$

XVI. *Formulæ for the Ratios of the Multiples of an Angle.*—Substituting A for B in (38), we have—

$$\text{Sin. } (A + A) = \sin. A \cos. A + \cos. A \sin. A;$$
$$\therefore \sin. 2A = 2 \sin. A \cos. A \ldots\ldots\ldots (52)$$

Similarly, by (35)—

$$\cos. (A + A) = \cos. A \cos. A - \sin. A \sin. A:$$
$$\therefore \cos. 2A = \cos.^2 A - \sin.^2 A. \ldots\ldots (53)$$

By (7), $1 = \sin.^2 A + \cos.^2 A$; adding this to (53)—

$$\text{Cos. } 2A = 2 \cos^2 A - 1 \ldots\ldots\ldots\ldots (54)$$

Subtracting (7) from (53)—

$$\text{Cos. } 2A = 1 - 2 \sin.^2 A \ldots\ldots\ldots\ldots (55)$$

Again, substituting A for B in (45), we have—

$$\text{Tan. } 2A = \frac{2 \tan. A}{1 - \tan.^2 A} \ldots\ldots\ldots\ldots (56)$$

Assuming A = B = C in (49)—

$$\text{Sin. } 3A = 3 \sin. A \cos.^2 A - \sin.^3 A$$
$$= 3 \sin. A\ (1 - \sin.^2 A) - \sin.^3 A$$
$$= 3 \sin. A - 3 \sin.^3 A - \sin.^3 A;$$
$$\therefore \sin. 3A = 3 \sin. A - 4 \sin.^3 A. \ldots (57)$$

Similarly, from (50)—

$$\cos. 3A = 4 \cos.^3 A - 3 \cos. A \ldots\ldots (58)$$

And from (51)—

$$\tan. 3A = \frac{3 \tan. A - \tan^3 A}{1 - 3 \tan.^2 A} \ldots\ldots (59)$$

XVII. *Formulæ for the Ratios of an Angle in terms of the Ratios of the Sub-multiples of that Angle.*—Substituting A for 2A on the left-hand side of (52) to (56), and therefore $\frac{A}{2}$ for A on the right-hand side, we have—

$$\text{Sin. } A = 2 \sin. \frac{A}{2} \cos. \frac{A}{2}. \ldots\ldots \ldots (60)$$

$$\text{Cos. } A = \cos.^2 \frac{A}{2} - \sin.^2 \frac{A}{2} \ldots\ldots (61)$$

$$\text{Cos. } A = 2 \cos.^2 \frac{A}{2} - 1 \ldots\ldots\ldots\ldots (62)$$

$$\text{Cos. } A = 1 - 2 \sin^2 \frac{A}{2} \ldots\ldots\ldots \ldots (63)$$

$$\text{Tan } A = \frac{2 \tan \frac{1}{2} A}{1 - \tan^2 \frac{1}{2} A} \ldots\ldots\ldots (64)$$

From (57), (58), and (59), like formulæ may be obtained, by like means, for sin. A, cos A, tan. A, in terms of the same ratios of $\frac{A}{3}$. The student should do this for himself.

In this lesson have been given those formulæ most likely to occur in after-practice. The student should not be content with reading the demonstrations, but should in every case write them out as he follows the proof, inserting any intermediate steps which, from their simple character, may have been omitted to save space. He should also arrange new formulæ for himself, as may be done to any extent by simple substitutions, or by additions, subtractions, and divisions of formulæ already given.

KEY TO EXERCISE 2.*

1. A = 61°; B = 29°; c = 35·065.
2. A = 61°; a = 297·5; b = 164·815.
3. A = 36°; a = 3·2715; c = 5·56.
4. B = 29°; a = 39·71; c = 45·38
5. A = 15°; B = 75°; c = 2588·2 ft.
6. A = 36°; B = 54°. b = 2126·5.
7. B = 15°; a = ·00483; b = ·001295
8. A = 29°; B = 61°; c = ·455
9. A = 40°; B = 50°.†
10. 31°; 60 ft.
11. 605 yds. and 745 yds. respectively (omitting fractions). As these distances were traversed in equal times, the speeds were proportional to the distances; hence the speed of the faster train was nearly 24½ miles per hour.

* These answers are only approximately correct, the table of ratios in Section X. having been purposely restricted to three places of decimals, to render calculations less difficult.

† Certain ratios of these angles were omitted from the table.

ELECTRICITY.—IX.

[Continued from p. 317.]

TESTS FOR THE ELECTROMOTIVE FORCE AND RESISTANCE OF BATTERIES.

THE goodness or badness of any particular type of cell largely depends upon the class of work for which it is being used. It will be found that for doing any given work the choice of the most suitable cell lies within very narrow limits, and that two of the most important factors in determining that choice are the E.M.F. and the resistance of the cell. Other considerations must also be taken into account, such as the constancy of the E.M.F., the constancy of the resistance, the fuming of the cell, the cost of materials, etc., but the E.M.F. and resistance are the two most important factors, since it is these that govern the strength of current that will flow through any given circuit. Where strong currents are required, and where the external resistance is very small, the cell chosen should have as small a resistance as possible; a high E.M.F. is always an advantage, but for the given case the resistance of the cell is the more important factor. On the other hand, where the external resistance is great, and where small currents are required—as would be the case in signalling through a long telegraph line—the resistance of the cell within ordinary limits is not nearly of so much importance as a high E.M.F.

The E.M.F. of any cell depends upon the nature of the materials composing it, and upon the temperature, but it is not a quantity that varies greatly in different cells of the same type, no matter how they may differ in size. We know, for instance, that the E.M.F. of a Grove is about 1·94 volts, and it will have this E.M.F. all the world over. The resistance of a cell, however, is by no means a fixed quantity for any particular type, depending as it does, not only upon the nature of the materials, but also upon their dimensions, and their relative arrangement. To know how to test both the E.M.F. and the resistance of any cell is a necessary part of the education of anyone working with them. The following are some of the methods which are in general use:—

MEASUREMENT OF THE RESISTANCES OF BATTERIES.

Half Deflection Method.—For this method we require a resistance-box, a galvanometer, and a key, which should be connected up as shown in Fig. 44.

Two observations must be made, thus:—

OBSERVATION (1).—Depress the key so as to send a current through the resistance R and the galvanometer G, and then adjust the resistance till there is a convenient deflection on the galvanometer.

OBSERVATION (2).—Increase the resistance in R till the deflection on the galvanometer has been reduced to half its previous value.

Let B = the resistance of the battery.
„ G = „ „ „ galvanometer.
„ r = „ „ introduced in case (1).
„ R = „ „ „ „ (2).

Then,

$$B = R - 2r - G.$$

This method only holds good when the deflection on the galvanometer is proportional to the current

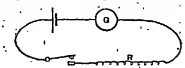

Fig. 44.

passing, as would be the case with a Thomson reflecting galvanometer. If a tangent galvanometer is used, the method also holds good if the following modification is introduced:—Instead of making the second deflection half the first one, make the tangent of the second deflection equal to half the tangent of the first one.

The method will hold good when using any galvanometer *if we can make the current in the second observation half what it was in the first.*

The proof of the formula is as follows:—

Let E = the E.M.F. of the cell.

„ C = the current passing in the first observation.

Then by Ohm's law, in case (1),

$$E = C(B + r + G),$$

and in case (2),

$$E = \frac{C}{2}(B + R + G);$$

$$\therefore\ C(B + r + G) = \frac{C}{2}(B + R + G),$$

$$\therefore\ 2B + 2r + 2G = B + R + G,$$

$$\therefore\ B = R - 2r - G.$$

This method is most accurate when r and G are very small compared with R. We must therefore use a low-resistance galvanometer when possible. Not only a single cell, but a large battery can be tested by this method.

EXAMPLE 1. — A battery consisting of 10 Leclanché cells in series was connected up with a reflecting galvanometer, having a resistance of 1 ohm, as shown in Fig. 44; and on introducing a resistance of 23 ohms into the circuit, there was a deflection of 260 divisions. On increasing the resistance in the box to 75 ohms, the deflection was reduced to 130 divisions. What was the resistance of the battery?

Here $R = 75$ ohms.
" $r = 23$ "
" $G = 1$ "
Then,

$$B = 75 - 2 \times 23 - 1$$
$$= 28 \text{ ohms.} \qquad \textit{Answer.}$$

or 2·8 ohms for each cell.

Equal Deflection Method (Thomson's method).—This, like the previous one, requires two observations, but has the advantage that any kind of galvanometer can be used. The connections are arranged as shown in Fig. 45.

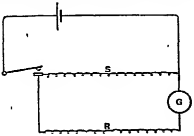

Fig. 45.

OBSERVATION (1).—With the connections shown in Fig. 45, adjust the resistance R till there is a convenient deflection on the galvanometer.

OBSERVATION (2).—Remove the shunt—when it will be found that the deflection will increase—and increase the resistance in R till the deflection is the same as it was in case (1).

Let S = the resistance of the shunt in case (1).
" r = " in the main circuit in case (1).
" R = " " " " " (2).
Then,

$$B = S\frac{R - r}{r + G}.$$

The truth of this formula can be verified by simplifying the following two equations obtained from two cases:—

In case (1),

$$C = \frac{E}{B + \frac{S(r+G)}{S + r + G}} \times \frac{S}{r + G + S},$$

and in case (2),

$$C = \frac{E}{B + R + G}.$$

The test is most accurate when the resistance of the shunt is made less than that of the battery, and the quantity $G + R$ is made as large as possible.

EXAMPLE 2.—A battery consisting of 30 Daniell cells in series was connected up as shown in Fig. 45, and the following figures were obtained:—

OBSERVATION (1).—
$r = 100$ ohms, deflection = 360 divisions.
$S = 1$ ohm.

OBSERVATION (2).—
$R = 4500$ ohms, deflection = 360 divisions.

The galvanometer had a resistance of 10 ohms. Substituting these figures in the formula we get

$$B = 1\,\frac{4500 - 100}{100 + 10}$$
$$= 40 \text{ ohms.} \qquad \textit{Answer.}$$

or 1·33 ohms for each cell.

Another Equal Deflection Method.—This test also requires two observations, and the connections as shown in Fig. 46 are not unlike those in Thomson's method.

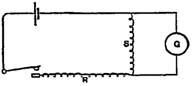

Fig. 46.

OBSERVATION (1).—With the connections shown in Fig. 46 adjust the resistance R till a convenient deflection is obtained on the galvanometer.

OBSERVATION (2).—Remove the shunt S, and increase the resistance R till the deflection is the same as in (1).

Then the resistance of the battery can be obtained from the following formula:—

$$B = \frac{S}{G}(R - r) - r.$$

Where S = the resistance of the shunt used in (1).
" r = " " in main circuit in (1).
" R = " " " " (2).
" G = " " of the galvanometer.

The truth of the formula can be verified by simplifying the following two equations obtained from (1) and (2):—

For case (1)—

$$C = \frac{E}{B + r + \frac{G \times S}{G + S}} \times \frac{S}{G + S}.$$

For case (2)—

$$C = \frac{E}{B + R + G}.$$

For accurate work the shunt S should be made small.

EXAMPLE 3.—With one Bichromate cell the following figures are obtained:—

OBSERVATION (1).—
$r = 2$ ohms, deflection = 250 divisions.
$S = 2$ " " = " "

resistance R adjusted till the same deflection is obtained as in (1).

Let E = the E.M.F. of the standard cell.
„ B = the resistance of the standard cell.
„ E_1 = the E.M.F. of the cell or battery under test.
„ B_1 = the resistance of the cell or battery under test.
„ R = the resistance in main circuit in (1).
„ R_1 = „ „ „ (2).
„ G = the resistance of galvanometer.

Then,

$$E_1 = E\frac{B_1 + R_1 + G}{B + R + G},$$

but as the resistances of the cells are usually extremely small compared with the other resistances in circuit, they can be omitted without any appreciable error, and then the formula can be written in the following simple form :—

$$E_1 = E\frac{R_1 + G}{R + G}.$$

EXAMPLE 5.—Whilst testing a Leclanché, and using a Daniell as standard, we got the following figures:—

OBSERVATION (1).—

E = 1·08 volts, B = 1·5 ohms, R = 650 ohms.

OBSERVATION (2).—

B_1 = 2·5 ohms, R_1 = 1,000 ohms.
G = 350 ohms.

Substituting these figures in the formula we get

$$E_1 = 1{\cdot}08\,\frac{350 + 1000 + 2{\cdot}5}{350 + 650 + 1{\cdot}5}$$
$$= 1{\cdot}46 \text{ volts.} \qquad \textit{Answer.}$$

And it will be noticed that practically the same result would be obtained if the resistances of the cells were neglected.

Any type of galvanometer can be used for this test provided it is sufficiently sensitive.

Equal Resistance Method.—The connections for making this test are the same as for the previous one, Fig. 51. The resistance R is, however, not a variable, but a fixed resistance of over 5,000 ohms. The galvanometer used must be either direct-reading, or it must be calibrated so that its readings can be translated directly into current. A reflecting galvanometer is the most convenient to use for this test.

OBSERVATION (1).—The standard cell is inserted, the key depressed, and the deflection of the galvanometer noted. In order that this deflection may be a convenient one, the galvanometer should be provided with a shunt of adjustable resistance; this shunt is then varied till the deflection has attained a convenient value. The same shunt must, of course, be used for tests (1) and (2).

OBSERVATION (2).—The standard cell is removed, the other one put in its place, the key depressed, and the deflection again noted.

Then,

$$E_1 = E\frac{D_1}{D}.$$

Where E = E.M.F. of standard cell.
„ D = deflection with standard cell.
„ E_1 = E.M.F of cell or battery.
„ D_1 = deflection with cell or battery.

EXAMPLE 6.—An accumulator when tested by this method gave the following figures :—

OBSERVATION (1).—

E = 1·08 volts, D = 170 divisions.

OBSERVATION (2).—

E_1 = , D_1 = 340 divisions.

Then,

$$E_1 = 1{\cdot}08\,\frac{340}{170}$$
$$= 2{\cdot}16 \text{ volts.} \qquad \textit{Answer.}$$

Where a number of cells are to be tested, a very convenient modification of this test is as follows :— In observation (1) adjust the shunt till the deflection is exactly 108 divisions. This avoids all calculation, since—keeping the shunt constant—the deflection of the galvanometer divided by 100 gives the E.M.F. of any cell; thus, a cell that would give a deflection of 194 divisions has an E.M.F. of 1·94 volts; one that would give a deflection of 216 divisions has an E.M.F. of 2·16 volts.

Assisting and Opposing Method.—Two observations must be made with the connections shown in Fig. 52.

OBSERVATION (1).—With the connections shown in Fig. 52 E is the standard cell, and E_1 the test

Fig. 52

cell, and it will be noticed that both cells tend to drive the current through the circuit in the same direction. The key is depressed, and the resistance R adjusted till a convenient deflection is obtained.

OBSERVATION (2).—The test cell remaining in the same position, the standard cell is reversed, so that it now tends to send a current in the opposite direction through the circuit. If the test cell has a higher E.M.F. than the standard, the current will flow through the circuit in the same direction as in

the current circulates through the different resistances is indicated by the arrows in Fig. 49.

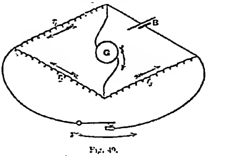

Fig. 49.

And the current flowing through the galvanometer is

$$C = \frac{E}{B + \dfrac{\left(\dfrac{r_2 \times r_3}{r_2 + r_3} + G\right) r_1}{\dfrac{r_2 \times r_3}{r_2 + r_3} + G + r_1}} \times \frac{r_1}{\dfrac{r_2 \times r_3}{r_2 + r_3} + G + r_1}.$$

The two equations look complex, but they work down into the extremely simple formula given above. The formula is so simple that it is not necessary to give an example on it.

Kempes' Method.—Two observations required. A condenser F, a ballistic or slow-swinging reflecting galvanometer G, and a known resistance R are connected up as shown in Fig. 50.

The principle of the condenser has not yet been explained, but for the present it is sufficient to

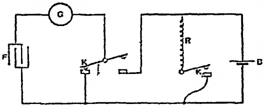

Fig. 50.

know that a combination of a condenser and a ballistic galvanometer arranged as above can be used for measuring volts. The condenser, as shown in Fig. 50, is permanently short-circuited through the galvanometer G by the Morse key K.

OBSERVATION (1).—Depress the key K, and there will be a momentary deflection on the galvanometer—such a deflection is usually known as a "throw." The throw is caused by the sudden rush of electricity, or momentary current, which passes through the galvanometer in order to charge the condenser. The charging of the condenser is practically an instantaneous process, and when it has taken place no further current can flow. On releasing the key K the condenser will discharge back through the galvanometer, and will produce on it a throw equal to the first one, but in the opposite direction.

OBSERVATION (2).—Depress the key K_1 so that the current now circulates through the known resistance R. Whilst the key K_1 is depressed, depress the key K, and take another throw on the galvanometer—this throw will be less than the previous one—then

$$B = R\frac{D_1 - D_2}{D_2}.$$

Where D_1 = the throw in (1).
" D_2 = " " " (2).
" R = the resistance in circuit in (2).

This method is the same in principle as the amperemeter and voltmeter method, and is one of the best and simplest to work of them all.

For accurate working the second throw should be nearly half the first, which means that the resistance R should be nearly equal to the resistance of the battery under test.

COMPARISON OF THE ELECTROMOTIVE FORCES OF BATTERIES.

In order to determine the E.M.F. of any cell or battery, it is necessary to compare it with some standard cell whose E.M.F. is a known and a fixed quantity, such as a Clark's standard cell, whose E.M.F. is 1·434 volts, or one of the many forms of Daniells. For several of the tests that follow the Clark cell cannot be used, since this cell is injured if allowed to send a current through a resistance of less than 1,000,000 ohms. Some form of Daniell cell is usually the best to use where great accuracy is not required.

Equal Deflection Method.—Two observations are made with the connections as shown in Fig. 51.

OBSERVATION (1).—The standard cell E is placed as shown, the key is depressed, and the variable

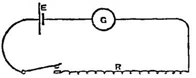

Fig. 51.

resistance R is then adjusted till a convenient reading is obtained on the galvanometer.

OBSERVATION (2).—The standard cell is removed, and the cell or battery to be tested is put in its place; the key is depressed, and the

	Singular.			*Plural.*
	MASC.	FEM.	NEUT.	FOR ALL GENDERS.
Nom.	Der,	die,	das, the.	Die, the.
Gen.	Des,	der,	des, of the.	Der, of the.
Dat.	Dem,	der,	dem, to *or* for the.	Den, to *or* for the.
Acc.	Den,	die,	das, the.	Die, the.

	Singular.		
	MASC.	FEM.	NEUT.
Nom.	Ein,	eine,	ein, an *or* a.
Gen.	Eines,	einer,	eines, of an *or* a.
Dat.	Einem,	einer,	einem, to *or* for an *or* a.
Acc.	Einen,	eine,	ein, an *or* a.

This article can obviously have no plural.

Certain prepositions are frequently contracted with the dative and accusative of the definite article into one word.

EXAMPLES.

Dat. Am,	for an dem,	as, am Feuer, at the fire.
Acc. Ans,	an das,	ans Licht, to the light.
Acc. Aufs,	auf das,	aufs Haus, upon the house.
Dat. Beim,	bei dem,	beim Vater, with the father
Acc. Durchs,	durch das,	durchs Wasser, through the water.
Acc. Fürs,	für das,	fürs Geld, for the money.
Dat. Hinterm,	hinter dem,	hinterm Hause, behind the house.
Dat. Im,	in dem,	im Himmel, in (the) heaven.
Acc. Ins,	in das,	ins Haus, into the house.
Dat. Vom,	von dem,	vom Übel, from (the) evil.
Acc. Vors,	vor das,	vors Fenster, before the window.
Dat. Vorm,	vor dem,	vorm Thore, before the gate
Dat. Überm,	über dem,	überm Feuer, upon the fire.
Acc. Übers,	über das.	übers Land, over (the) land.
Dat. Unterm,	unter dem,	unterm Wasser, under (the) water.
Dat. Zum,	zu dem,	zum Flusse, to the river.
Dat. Zur,	zu der,	zur Ehre, to the honour.

NOUNS.

In German, as in English, the nouns (that is, the *names* of persons and things) are divided into two great classes—viz., *Common nouns*, which designate sorts, kinds, or classes of objects; and *Proper nouns*, which are peculiar to individuals.

The student will bear in mind the following rules:—

(*a*) In German all *Nouns*, as also all parts of speech when used as nouns, begin with a capital letter, as:—(1) Der Sohn, the son; die Tochter, the daughter. (2) Der Gute, the good (man); die Gute, the good (woman). (3) Das Singen, the singing.

(*b*) Also: *The Indefinite Pronouns*, as:—Jemand, anybody, somebody; Jedermann, everybody; Etwas, anything, something; and Nichts, nothing.

Note, that when Etwas and Nichts are connected with a noun, or with an adjective used as a noun, they do *not* begin with a capital, as:—Er hat etwas Brod, he has *some* bread; Er hat nichts Gutes, he has *nothing* good.

(*c*) Also: *The absolute Possessive Pronoun*, when used substantively, as:—Die Meinigen, my family; das Meinige, my property.

(*d*) Also: *The Indefinite Numerals*, when used without a substantive, as:—Alles, Alle, all; Einige, some; Mancher, many a; Viele, many.

(*e*) Also: *The Personal Pronouns*, Du, Ihr (thou, you), etc., when we would distinguish thereby the person addressed.

(*f*) Also: Ein, when a numeral adjective, and likewise when a pronoun as distinguished from the article, as:—Ich habe nur Einen Freund, I have only *one* friend; Das Eine Pferd ist blind, das andere ist lahm, the *one* horse is blind, the other is lame.

(*g*) Lastly: Adjectives derived from names of persons, as:—Das Schillerische Haus. Observe, that adjectives derived from the names of countries do *not* begin with a capital, as:—Der deutsche Bund, the German confederacy; die französische Sprache, the French language.

Under the head of common nouns are commonly included several subdivisions: as, *Collective nouns*, which are the names of a *plurality* of individuals considered as *unity*; and *Abstract nouns*, which are the names of certain qualities or attributes regarded as separate from any given substance.

The nouns, both common and proper, as before said, are regularly inflected; thus exhibiting, by means of terminations, the several modifications of gender, number, and case. The numbers and cases will be made sufficiently clear under the head of *Declension of Nouns*.

GENDER.

Strictly speaking, the masculine gender belongs exclusively to words denoting males; the feminine, to those denoting females; and the neuter to such only as are neither male nor female. And in English, accordingly, with very little exception, this is found to be actually the case.

Not so, however, in German; for there the names of many things *without* life (from their real or supposed possession of *qualities* pertaining to things *with* life) are considered and treated as masculine or feminine. Often, moreover, words indicating things without life are deemed masculine or feminine, merely from some resemblance in *form* to those designating things properly male or female. Hence arises, in grammar, the distinction between the *natural* and the *grammatical* gender of words.

Were the natural gender alone regarded, it

(1); if the E.M.F. of the test cell is equal to that of the standard, then no current will flow; and if the E.M.F. of the test cell is less than that of the standard, then the current will flow through the circuit in the opposite direction to its direction in (1). The resistance in R must be kept the same for both tests.

Then,

$$E_2 = E\frac{D_1 + D}{D_1 - D}.$$

Where D_1 is the deflection in (1).
" D " " " (2)

This formula only holds good when the deflection is proportional to the current. If a tangent galvanometer was used the formula would become

$$E_1 = E\frac{\tan D_1 + \tan D}{\tan D_1 - \tan D}.$$

It is clear that if the E.M.F. of the test cell is less than that of the standard, the current will flow in the opposite direction through the circuit, and the deflection on the galvanometer will be to the opposite side of zero. Such a deflection must be looked upon as negative, and the above formula will then become

$$E_2 = E\frac{D_1 - D}{D_1 + D}.$$

and

$$E_1 = E\frac{\tan D_1 - \tan D}{\tan D_1 + \tan D}.$$

This method, as may be seen, is quite independent of the resistances of the cells, and is more suitable for testing the E.M.F.'s of single cells than of large batteries.

EXAMPLE 7.—Performing the above test on a single Leclanché cell, the following figures were obtained:—

OBSERVATION (1).—

E = 1·08 volts, D_1 = 261 divisions.

OBSERVATION (2).—

E_1 = D = 22 divisions.

Substituting these figures in above formula we get

$$E_1 = 1·08\frac{261 + 22}{261 - 22}$$
$$= 1·296 \text{ volts.} \qquad \textit{Answer.}$$

This E.M.F. is below the usual value for a Leclanché, showing the cell was partly polarised.

Potentiometer Method.—The method here described is a slight modification of Poggendorff's method. There are two observations made with the connections shown in Fig. 53.

In this figure A B is wire of uniform resistance at each part, and E_0 is a battery which is sending a permanent current through the resistance A B, G is a galvanometer, L is the standard and E_1 the test cell, whilst K and K_1 are keys.

The E.M.F. maintained between the points A and B by the battery E_0 must be greater than the E.M.F.

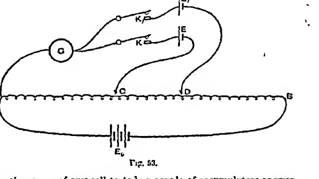

Fig. 53.

of any cell tested; a couple of accumulators answer excellently.

OBSERVATION (1).—Depress the key K, and notice if there is any deflection on the galvanometer; whether there is any deflection or not entirely depends upon the position of the movable contact C on the wire A B. If the contact C is too near A, a current will flow through the galvanometer in one direction: if it is too far from A, a current will flow through the galvanometer in the other direction, whilst if it is in the correct position no current will flow through G. This correct position means that the E.M.F. of the cell E is equal to the E.M.F. working between the points A and C. As the E.M.F. falls uniformly along a resistance, we may look upon the resistance of the wire between the points A and C, or the length of that wire, as proportional to the E.M.F. of the standard cell E.

OBSERVATION (2).—Depress key K_1 and adjust the contact D till no current flows through the galvanometer, as in (1). The resistance A D, or the length of that wire, is now proportional to the E.M.F. of the test cell E_1.

Therefore

$$E_1 = E\frac{AD}{AC}.$$

Having adjusted both contacts separately, it is well to depress both keys at the same time, as a final test to see if the E.M.F. of the source has changed whilst making the adjustments.

Condenser Method.—This method has been partially explained when speaking of Kempe's method for measuring the resistance of a battery.

Two observations are required with the connections as shown in Fig. 54.

OBSERVATION (1).—With these connections a throw is obtained on the galvanometer from the standard cell E by depressing the key K.

OBSERVATION (2).—Remove the standard and put the test cell in its place, depress the key, and note the throw on the galvanometer.

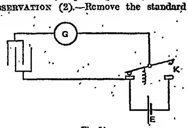

Fig. 54.

Then

$$E_1 = E\frac{D_1}{D}.$$

Where D_1 = throw obtained from test cell.
" D = " " " standard cell.

With a little practice this is a quick and an accurate method of testing.

GERMAN.—XXX.

[*Continued from p. 321.*]

DERIVATION AND COMPOSITION (*continued*).

IN respect to COMPOUNDS, properly so called—that is, words formed by the union, not of prefixes and suffixes with radicals, but of radicals, or other independent words, one with another—German is peculiarly rich. Not only is it rich in the abundance of such compounds already in use, but it possesses a rare facility of forming them, as occasions arise, out of its own resources.

In forming these compounds, the two components are often merely joined together as one word, as:—Uhrmacher (from Uhr, a clock *or* watch, and Macher, a maker). But in numerous cases the union is marked by the insertion of certain letters, which may be called *letters of union*. Thus—

Die Todesnoth (from Tod, death, and Noth, need, agony), death-agony.

Das Himmelslicht (from Himmel, heaven, and Licht, light), the light of heaven.

Die Herzensgüte (from Herz, heart, and Güte, goodness), the goodness of heart.

Der Pferdearzt (from Pferd, horse, and Arzt, doctor), the horse-doctor.

Das Hirtenleben (from Hirt, shepherd, and Leben, life), the pastoral life.

Der Eierkuchen (from Ei, egg, and Kuchen, cake), the omelet.

Some of these letters of union are nothing more than the signs of the genitive case of the first component; others are mere euphonic additions.

In some instances the union of the parts of a compound is characterised by the *omission* of some letters, as:—Der Sonntag (Sonne, the sun, and Tag, day), Sunday; Denkwürdig (denken, to think, and würdig, worthy), worthy of thought.

Finally, in all compounds, the main accent falls upon the *first* component (which always qualifies or defines the second), as containing the fundamental idea.

PARTS OF SPEECH.

The parts of speech in German are usually said to be ten: namely, Articles, Nouns or Substantives, Adjectives, Numerals, Pronouns, Verbs, Adverbs, Prepositions, Conjunctions, and Interjections.

Of these, *six* (namely, Articles, Nouns, Adjectives, Numerals, Pronouns, and Verbs) are capable of *inflection*—that is, admit of changes of termination by which various modifications of meaning are expressed; the other *four* (namely, Adverbs, Prepositions, Conjunctions, and Interjections) are in form *invariable*.

All parts of speech capable of inflection have two numbers: the Singular, which denotes but one; and the Plural, which denotes more than one.

All parts of speech capable of inflection, except the verb, have four Cases: namely, the Nominative, Genitive, Dative, and Accusative. Also, three Genders: namely, the Masculine, the Feminine, and the Neuter.

Cases are variations made in the form of a word to indicate its several relations to other words: the nominative being that form which denotes the *subject* of a verb; the genitive, that which is chiefly used in signifying *source* or *possession*; the dative, that which indicates the person *to* whom, or thing *to* which, an action is directed; and the accusative, that which points to the *immediate* or *direct* object of an action.

The cases in German correspond closely to those of the Latin language. The *Vocative*, however, has never in German, as it sometimes has in Latin, a distinct form to mark it off from the nominative; while the *Ablative* (as in Greek) is wholly wanting, its place being generally supplied by the Dative (with a suitable preposition).

THE ARTICLE.

There are two articles in German: the definite, der, *the*; and the indefinite, ein, *a* or *an*. They are inflected thus:—

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would be necessary only to know the MEANING of a word to know its gender; but since this is not the case, we are often obliged to determine gender chiefly by the FORM. We give below, therefore, the principal rules for determining the gender in either way; suggesting only, as the best mode of learning the *exceptions* (which are numerous, and here purposely omitted), the custom of constantly and carefully noting them in reading and speaking.

RULES FOR DETERMINING GENDER.

BY THE MEANING.	BY THE FORM.
(1) To the Masculine belong the names of—	(1) To the Masculine belong—
Male beings: as, der Mann, the man; der Löwe, the lion.	
Days: as, der Montag, Monday; der Dienstag, Tuesday.	
Months: as, der Januar, January; der Februar, February.	(*a*) Those primary derivatives ending in the *insignificant* suffixes -er, -el, -en; and those also that are without affixes of any kind.
Seasons: as, der Frühling, spring; der Sommer, summer.	
Winds: as, der Nordwind, the North wind; der Südwind, the South wind.	
Points of the Compass: as, der Nord, the North; der Süd, the South.	(*b*) Those secondary derivatives formed by means of the *significant* suffixes -er, -ig, -ing, and -ling.
Mountains: as, der Harz, the Harz; der Atlas, the Atlas.	
Stones: as, der Diamant, the diamond; der Rubin, the ruby.	
Fruit-trees: as, der Birnbaum, the pear-tree; der Apfelbaum, the apple-tree.	
(2) To the Feminine belong the names of—	(2) To the Feminine belong—
Female beings: as, die Frau, the wife; die Tochter, the daughter.	(*a*) Those primary derivatives ending in -e, -t, -st, -t (ft), -de.
Rivers: as, die Weser, the Weser; die Themse, the Thames.	
Fruits: as, die Birne, the pear; die Nuß, the nut.	(*b*) Those secondary derivatives formed by means of the suffixes -e, -ei, -in, -heit, -keit, -schaft, -ung.
Trees and flowers: as, die Birke, the birch; die Erle, the alder; die Rose, the rose.	
(3) To the Neuter, belong the names of—	(3) To the Neuter belong—
Countries and places: as, Frankreich, France; Berlin, Berlin.	
Metals: as, das Silber, silver.	
Materials: as, das Holz, wood.	
Letters: as, das A, the A; das B, the B, etc.	(*a*) Those secondary derivatives formed by means of the suffixes -chen, -lein, -el, -sal, -sel, -niß, -thum.
Infinitives used as Nouns: as, das Leben, life; das Reiten, riding.	
Many individuals taken together (*i.e., Collective Nouns*): as, das Heer, the host.	
Adjectives used as Nouns (in an abstract and indefinite way): as, das Gute, the good; das Schöne, the beautiful.	(*b*) Those nouns having the augment ge-.
Pronouns and Particles used Substantively: as, sein liebes Ich, his beloved self; das Wie und das Wo, the how and the where.	

Under the name of *male beings* must be included that of the Almighty, as also those of angels and other superior powers; those of mythological deities and of human beings; those of beasts, birds, reptiles, and fishes. The term *female beings* must have a like latitude of signification.

GENDER OF COMPOUNDS AND FOREIGN WORDS.

Compounds in general adopt the gender of their last component: as—

Die Hofkirche (from Hof, court or yard, and Kirche, church), court church.
Der Kirchhof, the churchyard.
Der Eichbaum (from die Eiche, the oak, and der Baum, tree), the oak tree.
Die Windmühle (from der Wind, the wind, and die Mühle, mill), the windmill.
Das Rathhaus (from der Rath, council, and das Haus, house), the council-house.

Foreign words, for the most part, when taken into the German language, retain their original gender. Those, however, that have become wholly Germanised often take a different gender, as they take a different form; thus, *Corpus* (the body), which in Latin is *neuter*, becomes in German der Körper, which is *masculine*.

DERIVATION OF NOUNS.

To what has been already said concerning the derivation of nouns, we add here, before entering upon the subject of Declension, a brief view of the *secondary derivatives*. which are made by *significant* suffixes. For the sake of the learner we subjoin a list of the leading suffixes of this class; putting in brackets the equivalent English terminations, explaining severally their force and use, and illustrating the whole by suitable examples.

SUFFIXES USED IN FORMING NOUNS.

SUFFIXES.	ENGLISH EQUIVALENTS.	MEANING.
-er	[*-er*, *-ier* or *-yer*, *-zen*]	designates (*male*) *persons*: also, *agents* or *instruments*.
-ing, or -ling	[*-ling*, *-aster*]	denotes (often *contemptuously*) *persons*, *animals*, and *things*.
-in	[*-ess*, *-ix*]	designates (*female*) *persons*.
-ei	[*-y*, *-ry*, *-ary*, *-ery*, *-ory*]	indicates the *act*, *practice*, or *place of business*.
-ung	[*-ing*, *-ure*, *-ion*]	signifies the *act* or the *continuing to act*.
-e -heit -keit	[*-ness*, *-ity*, *-th*] [*-ness*, *-ity*, *-th*] [*-ness*, *-ity*, *-th*]	denote *qualities* or *attributes*.
-schaft -thum	[*-ship*, *-hood*, *-ity*] [*-dom*, *-hood*, *-ity*]	express *rank*, *grade*, *office*; also, a *number of things taken collectively*.
-sal -sel -niß	[*-vde*, *-cy*] [*-ude*, *-cy*] [*-ness*, *-cy*]	denote the *state* or *condition*: sometimes the *result*.
-chen -lein	[*-kin*, *-ule*, *-et*, *-let* [*-kin*, *-ule*, *-et*, *-let*	indicate *diminutiveness*.

EXAMPLES.

SUFFIXES.	NOUNS.
-er	Sänger, a singer; Bürger, a citizen; Säger, a sawyer; Schneider, a tailor; Römer, a Roman; Leipziger, a resident of Leipzig; Wiener, a Viennese.
-ling	Häuptling, a captain; Flüchtling, a fugitive; Miethling, a hireling; Dichterling, a poetaster; Hänfling, a linnet; Schößling, a shoot *or* sprig.
-in	Gräfin, a countess; Heldin, a heroine; Königin, a queen; Professorin, a professor's wife; Löwin, a lioness.
-ei	Dieberei, thievery; Heuchelei, hypocrisy; Fischerei, fishery; Brauerei, brewery.
-ung	Belehrung, teaching (*i.e.*, the *act* of teaching); Erbauung, the building, *or* erecting, edification; Krönung, the crowning, *or* coronation; Sitzung, the sitting, *or* session.
-e -heit -keit	Güte, goodness: Stärke, strength; Krankheit, sickness: Dummheit, stupidity; Heiligkeit, holiness; Feuchtigkeit, humidity.
-schaft -thum	Freundschaft, friendship; Priesterschaft, priesthood (that is, the *body* of the priests), Bereitschaft, readiness; Heidenthum, heathendom, heathenism: Christenthum, Christianity; Eigenthum, property.
-sal -sel -niß	Mühsal, the *state* of being in trouble, distress; Häcksel, that which has *resulted* from hacking and cutting—that is, cuttings (of straw): Bedürfniß, the *state* of being in want, necessity; Gleichniß, simile, parable.
-lein -chen	Büchlein, a *little* book; Knäblein, a *little* boy; Stühlchen, a *little* chair; Eichen, a *little* egg.

Appellatives derived from the names of places and countries have the termination -er, as.—Der Londoner, the Londoner. Names of countries, like Sachsen, Saxony, Preußen, Prussia, etc., being originally the names of the people, not of the countries, cannot take -er.

Nouns derived from the name of a city or town are often used indeclinably as adjectives, as:—Das Leipziger Bier, the Leipzig beer (gen. Des Leipziger Biers, of the Leipzig beer).

It must be observed, in forming derivatives of the order illustrated above, that when a, o, u, or au is contained in the radical part, it is modified into ä, ö, ü, or äu, upon receiving a suffix containing the vowel i or e (as -er, -el, -ling, -in, -ig, -ing, -chen, -lein, -e, -niß, and -sel); as in the case of Hündin (from Hund), Bürger (from Burg), and others of the like kind.

Often, moreover, in forming secondary derivatives certain *euphonic* letters are inserted between the suffix and the word to which it is added: as ig in Feuchtigkeit, humidity. Other letters employed in this way are en, n, and t. These euphonic parts are easily distinguished from those having an influence on the meaning by merely resolving the derivative into its elements.

Here, too, may be noted the particle ge-, which, being prefixed to certain primary words, forms a class of nouns denoting either *frequency* of action or a *collection* of things. These words, also, most commonly suffix the letter e, as:—Gerede, constant talk; Geheul, continuous howling; Gebirge, a range of mountains, etc.

DECLENSION OF COMMON NOUNS.

In German there are two declensions, distinguished as the *Old* and the *New*. The characteristic of each is the termination of the genitive singular. In the former, the genitive is formed from the nominative by adding -*es* or -*s*. When the genitive is otherwise formed, the noun is of the New Declension.

To the Old Declension belong almost all masculine and neuter nouns; that is, by far the greater part of all the nouns in the language.

In both declensions, the nominative, genitive, and accusative plural are alike in form; while the dative plural terminates always in the letter *n*. Unless, therefore, the word declined already ends in that letter, it is, in the dative, uniformly assumed.

All *feminine* nouns are invariable in the singular; in the plural they are, for the most part, inflected according to the New Declension.

In compounds, the *last* word only is subjected to the variations of declension.

KEY TO TRANSLATION FROM GERMAN (p. 320).

A MISUNDERSTANDING.

One morning, a young Prussian officer came into an inn on the Rhine, and ordered a pickled herring, which was soon brought to him in caper sauce.

Not far from him sat an Austrian officer, who addressed him pleasantly, and said: "That is rather good, is it not? I have seen it growing in Italy."

"You seem jestingly inclined," answered the Prussian; "but I must entreat you not to try to impose such nonsense upon me."

"No nonsense at all. I am quite serious."

"Ridiculous! How can you assert such a thing?"

"I tell you, I have seen it; they grow on bushes."

"And I do not want any such jokes! Seek another for such ridiculous assertions."

"Not ridiculous at all. It is true. You can believe me; I have seen it with my own eyes."

"Then, I will open your eyes," said the Prussian angrily; "I am tired of it—to be humbugged with such absurd jokes."

"That is too much," said the Austrian.

"Well, in that case," continued the Prussian, more excitedly, "come to-morrow morning at nine o'clock into the neighbouring wood, with a second, and I will give you an answer with a bullet."

"Very well!" said the Austrian, and finished his wine.

The next morning the two appeared, with their comrades, at the appointed hour, in the little wood.

The duel was carried out in due form. The Austrian, as the insulted party, shot first, and missed. The Prussian then fired, and hit him in the upper arm.

When the wound was bound up, the Prussian went up to him, and said: "Now, comrade, do you still assert that herrings grow on bushes?"

The Austrian replied good-naturedly: "Herrings! I did not mean herrings at all; I meant the capers!"

"And for this you have fought a duel!" exclaimed all the bystanders. AUERBACH.

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